January 15, 1991

Meeting Minutes Transmittal/Approval
Unit Managers Meeting: 200-BP-1 Operable Unit
450 Hills Street, Rm 47
December 18, 1990

From/
Appvl.: (as changed) Date: 1-24-91
Julie K. Erickson, 200-BP-1 Unit Manager, DOE-RL (A6-95)

Appvl.: Date: 1/24/91
Douglas R. Sherwood, 200-BP-1 Unit Manager, EPA (B5-01)

Appvl.: Date 1/24/91
Larry Goldstein, 200-BP-1 Unit Manager, WA Department of Ecology

---

Meeting Minutes are attached. Minutes are comprised of the following:

- Attachment #1 - Meeting Summary/Summary of Commitments and Agreements
- Attachment #2 - Agenda for the Meeting
- Attachment #3 - Attendance List
- Attachment #4 - Commitments/Agreements Status List
- Attachment #5 - December 7, 1990 Work Order
- Attachment #6 - Groundwater Well Installation, Task 6, Status, December. 17, 1990
- Attachment #7 - Groundwater Well Remediation
- Attachment #8 - Groundwater Sampling
- Attachment #9 - Source and Vadose Sampling

Prepared by: Date: 1/24/91
SWEC Support Services

Concurrence by: Date: 1/24/91
WHC RI Coordinator

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200-BP-1 Operable Unit Managers Meeting
December 18, 1990

Distribution:

Donna Lacombe, PRC
Ward Staubitz, USGS
Doug Fassett, SWEC (A4-35)
Jack Waite, WHC (B2-35)
Tom Wintczak, WHC (B2-15)
Mel Adams, WHC (H4-55)
Wayne Johnson, WHC (H4-55)
Rich Carlson, WHC (H4-55)
Brian Sprouse, WHC (H4-22)
Bill Price, WHC (SO-03)
Ralph O. Patt,
    OR Water Resources Dept.
Tim Veneziano, WHC (B2-35)
Doug Dunster, Golder Assoc.
Mike Thompson, DOE (A6-95)
Diane Clark, DOE (A5-55)
Mark Buckmaster, WHC (H4-55)

cc. Ronald D. Izatt (A6-95)
    Director, DOE-RL, ERD
Ronald E. Gerton (A6-80)
    Director, DOE-RL, WMD
Roger D. Freeberg (A6-95)
    Chief, Rstr. Br., DOE-RL/ERD
Steven H. Wisness (A6-95)
    Tri-Party Agreement Proj. Mgr
Richard D. Wojtasek (B2-15)
    Prgm. Mgr. WHC
Mary Harmon, DOE-HQ (EM-442)

ADMINISTRATIVE RECORD: 200-BP-1; Care of Susan Wray, WHC (H4-51C)

Please inform Doug Fassett (SWEC) of deletions or additions to the distribution list.

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Attachment #1

Meeting Summary and Summary of Commitments and Agreements

200-BP-1 Unit Managers Meeting
December 18, 1990

1. Action Item status (also see Attachment #4)

   #38 PNL gross gama tools are probably not acceptable to the USGS.
   #40 Ward Staubitz reported that the comments are being written up.
   #42 Open
   CLOSED

2. Work Plan changes

   None

3. Leak Detection Engineering Study (see Attachment #5)

   Copies of the study were provided to DOE (Julie Erickson) and the regulators.

4. Groundwater well installation status (see Attachment #6)

   Regarding well 699-55-55, Mr. Buckmaster indicated that WHC would like to complete the well *as originally planned* if the drilling problem cannot be resolved. Concern was expressed by Ward Staubitz (USGS) about otherwise obtaining information on the possibility of an erosional window in the basalt at this location. The one radiation detection *at well 299-E33-40* is believed to have been radon; samples have been sent to the lab. [Safety issues may affect the schedule.]*

5. Well remediation status and priorities (see Attachment #7)

6. Groundwater Sampling (see Attachment #8)

   Mr. Buckmaster indicated that an off-site lab has been selected and the selection has been submitted to procurement. It is expected that the lab will be on-line by the second week in January. Groundwater sampling is expected to start *January 3, 1991*.

7. Source and Vadose Sampling (see Attachment #9)

   Discussion of concerns about radiation exposure of the sampling personnel followed. If sampling personnel were to receive the estimated exposure per sample, they would receive the per week dose limit in less than a week, assuming sample collection at the specified 2.5 foot interval at the expected drilling rate. The discussion explored possible changes in sampling interval and other changes to the work plan to circumvent the problem. The regulators agreed that a continuously sampled bore hole in

* Proposed for deletion

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the area of the crib is necessary. Doug Sherwood (EPA) suggested that WHC sample according to the work plan for the first hole (in the 216-B-57 crib) before making revisions to the work plan.

8. <u>Well Summary Sheet</u>

Ward Staubitz (USGS) commented that the bore hole sampling summary sheet produced by Steve Trent was a good idea, and that a similar document should be produced for each vadose zone hole and presented to the regulators as they become available.

prior to drilling to use as an aid in getting information accross to field personnel ~~and~~

9. <u>Investigation Derived Wastes</u>

The disposition of investigation-derived wastes was discussed. Topics included the need to consolidate present materials and segregation of materials based on screening with field instrumentation. Doug Sherwood (EPA) said that a decision on handling the investigation-derived wastes would have to be made soon. A meeting to brainstorm this issue will be set-up for the first week in January. Mark Buckmaster (WHC) stated that all materials would be maintained on-site until drilling was completed, and then sampled. The material associated with the one detect of radioactivity were drummed separately and marked as radioactive. This material is located *within the* 200-BP-1 operable unit, and WHC is open to suggestions on handling such material.

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Attachment #2

Agenda

200-BP-1 UNIT MANAGERS MEETING
DECEMBER 18, 1990

Introduction:

Status:

Action Items:

Work Plan:

Remedial Investigation:

- Leak Detection Engineering Study
- Groundwater Well Construction
- Groundwater Well Remediation
- Groundwater Sampling
- Source and Vadose Sampling

Issues:

Other Topics:

Agreements and Commitments:

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Attachment #3

Attendance

200-BP-1 Operable Unit Managers Meeting
December 18, 1990

Name	Org.	O.U. Role	Phone
Julie Erickson	DOE-RL	Unit Manager	206-376-3603
Chuck Cline	Ecology	Geology	206-438-7556
Steve Cross	Ecology	CERCLA Unit	206-459-6675
Doug Sherwood	EPA	Unit Manager	206-376-9529
Donna Lacombe	PRC	EPA Contractor	206-624-2692
Carol Collins	SWEC	GSSC, DOE-RL	206-376-1009
Doug Fassett	SWEC	GSSC, DOE-RL	206-376-5011
Bill Fryer	SWEC	GSSC, DOE-RL	206-376-0412
Brian Drost	USGS	EPA Support	206-593-6510
Ward Staubitz	USGS	EPA Support	206-593-6510
Mark Buckmaster	WHC	RI Coordinator	509-376-1792
Rich Carlson	WHC	Env. Engineer	509-376-9027

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Attachment #4

Action Items

200-BP-1 Operable Unit Managers Meeting
December 18, 1990

Item Number	Action	Status
2BP1.38	Determine the USGS position on the feasibility of performing geophysical logging through cased wells. Action: Ward Staubitz for EPA (7/18/90, BP1.UMM)	Open: A geophysical meeting was held December 12-13, 1990 to resolve this issue.
2BP1.40	Status what the current logging capability is and how and when logging personnel will be mobilized. Action: Rich Carlson (9/20/90, BP1.UMM)	Closed
2BP1.42	Provide EPA and Ecology with the proposal for the work scope reduction. Action: Julie Erickson (10/16/90, BP1.UMM)	Open

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DISTRIBUTION SHEET

To:	From:	Date:
200/300 Environmental Engineering Section	Decommissioning Engineering	December 7, 1990

Project Title/Work Order:

An Evaluation of Techniques for Determining Potential Leaks from Underground Piping Systems in the 200-BP-1 Operable Unit

EDT No.: 121787 ECN No.: N/A

Name	MSIN	With Attachment	EDT/ECN & Comment	EDT/ECN Only
M. R. Adams	H4-55	X		
M. A. Buckmaster (5)	H4-55	X		
R. A. Carlson	H4-55	X		
R. G. Dieffenbacher	H4-16	X		
H. D. Downey	S0-04	X		
K. A. Gano	X0-21	X		
J. M. Garcia	R3-12	X		
W. M. Hayward (5)	R2-77	X		
R. P. Henckel	H4-55	X		
A. R. Johnson	T1-30	X		
W. L. Johnson	H4-55	X		
C. S. Krogness	R1-08	X		
M. J. Lauterbach	H4-55	X		
R. L. Martin	R3-20	X		
M. R. Morton	R2-77	X		
W. L. Osborne	T3-21	X		
K. S. Pedersen	S4-67	X		
R. W. Perusse	H4-16	X		
W. H. Price	S0-03	X		
J. B. Shannon	T3-21	X		
D. R. Speer	R2-77	X		
L. L. St. Georges	R1-08	X		
G. E. Van Sickle	R1-15	X		
B. F. Weaver	T3-21	X		
EDMC/AR	H4-22	X		
Central Files	L8-04	X		
Publication Services (3)	R1-08	X		

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DEC 10 1990

ENGINEERING DATA TRANSMITTAL

1. EDT 121787

2. To: (Receiving Organization) 200/300 Environmental Engineering Section	3. From: (Originating Organization) Decommissioning Engineering	4. Related EDT No: N/A
5. Proj/Prog/Dept/Div: 81490	6. Cog/Proj Engr: W. M. Hayward	7. Purchase Order No: N/A
8. Originator Remarks:		9. Equip/Component No: N/A
		10. System/Bldg/Facility: 200-BP-1 OU
11. Receiver Remarks:		12. Major Assm Dwg No: N/A
		13. Permit/Permit Application No. N/A
		14. Required Response Date: N/A

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-DD-ES-010		0	An Evaluation of Techniques for Determining Potential Leaks from Underground Piping Systems in the 200-BP-1 Operable Unit	3	1		

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 see MRP 5.43 and EP-1.7	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)

(G) Reason	(H) Disp	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp
1	1	Cog./Proj. Eng WM Hayward	W. M. Hayward	12/4/90	R2-77						
1	1	Cog./Proj. Eng. Mgr. DR Speer	D R Speer	12/4/90	R2-77						
1	1	QA RG Dieffenbacher	[signature]	12-4-90	H4-16						
		Safety									
1	1	MA Buckmaster	M. A. Buckmaster	12/4/90	H4-55						
1	1	WL Johnson	W L Johnson	12/4/90	H4-55						

18.	19.	20.	21. DOE APPROVAL (if required)
W. M. Hayward 12/4/90 Signature of EDT Originator / Date	W L Johnson 12/4/90 Authorized Representative for Receiving Organization / Date	D R Speer 12/5/90 Cognizant/Project Engineer's Manager / Date	Ltr No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments

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SUPPORTING DOCUMENT

1. Total Pages 65

2. Title	3. Number	4. Rev. No.
An Evaluation of Techniques for Determining Potential Leaks from Underground Piping Systems in the 200-BP-1 Operable Unit	WHC-SD-DD-ES-010	0

5. Key Words	6. Author
Tracer Gas, Helium, Leak Detection, Underground Piping, 200-BP-1, RI/FS	W. M. Hayward Name (Type or Print) W. M. Hayward Signature 81490/J814A Organization/Charge Code

7. Abstract

This engineering study evaluates existing technologies to detect where leaks may have occurred in underground pipelines within the 200-BP-1 Operable Unit. A total of two pipe penetration and seven leak detection alternatives are evaluated. The study provides a discussion of a wide scope of alternatives, establishes evaluation criteria and recommends selection of a preferred alternative. This engineering study directly supports Task 3 "Surface and Near Surface Soil Sampling and Analyses" of the 200-BP-1 Phase 1 RI.

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CONTENTS

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LIST OF FIGURES

LIST OF TABLES

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LIST OF TABLES (continued)

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LIST OF TERMS

ALARA	as low as reasonably achievable
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy-Richland Operations Office
EPA	U.S. Environmental Protection Agency
GC	gas chromatography
HEPA	high-efficiency particulate air (filter)
HPT	Health Physics Technician
ITS	in-tank solidification
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RI/FS	Remedial Investigation/Feasibility Study
SST	single-shell tank
TBP	tributyl phosphate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*

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1.0 OVERVIEW

In response to the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA 1980) and the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989), the U.S. Department of Energy-Richland Operations Office (DOE-RL) developed a work plan for the 200-BP-1 Operable Unit. This plan, entitled the *Remedial Investigation/ Feasibility Study Work Plan for the 200-BP-1 Operable Unit*, Hanford Site, Richland, Washington (DOE-RL 1990), was approved by the U.S. Environmental Protection Agency (EPA) in March 1990. The plan identified numerous investigation tasks that will provide information about the extent and level of contamination and the integrity of waste management facilities within the operable unit.

This document addresses a task in the work plan that required an evaluation of the integrity of the underground pipelines be performed. Study methods for accessing underground pipelines and detecting potential leaks from these pipelines are outlined. Two pipe penetration and seven leak detection alternatives were evaluated. Primary emphasis was placed on techniques that would not only determine if the pipe leaked, but also the approximate location of the leak. In addition, this document provides a discussion of a wide scope of alternatives, establishes evaluation criteria, and recommends selection of a preferred alternative for the detection of leaks from underground pipelines in the 200-BP-1 Operable Unit.

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2.0 INTRODUCTION

The 200-BP-1 Operable Unit is located in the 200 East Area of the Hanford Site, which is approximately 20 miles north of Richland, Washington (Figure 1). The operable unit includes 10 inactive cribs and three unplanned releases. One of the cribs (216-B-61) was constructed, but there is no documentation that it was ever used. As discussed in more detail later in this report, the operable unit also contains approximately 2,000 ft of underground pipeline used to service tank farm operations.

2.1 OBJECTIVE AND SCOPE

The objective of this engineering study is to evaluate existing leak detection technologies and to select a preferred method to detect where leaks may have occurred in underground pipelines within the 200-BP-1 Operable Unit. This engineering study directly supports Task 3, "Surface and Near Surface Soil Sampling and Analyses," of the 200-BP-1 Phase I Remedial Investigation (RI).

The scope of this study covers the underground pipelines described below, which are also highlighted in Figure 1.

- Two 4-in. lines that run the length (east and west) of the 241-BY Tank Farm (approximately 500 ft long). The lines were used to transfer waste from the BX/BY Tank Farm to the BC cribs and trenches outside the operable unit.
- A 2-in.-dia pipe that runs north, northwest, and then north again to the vicinity of the 216-B-43 through 216-B-50 Cribs (approximately 200 ft long). This pipe transferred condensates from the tank farm to cribs.
- A 2-in.-dia pipe that runs east and west 125 ft from and parallel to the north boundary to the vicinity of the concrete pads just northeast of the 216-B-46 Crib (approximately 500 ft long).
- The underground pipeline that runs north, northwest, and then west from the 241-BY Tank Farm fill area to the 216-B-61 Crib (approximately 590 ft long). Although it may never have been used, the purpose of this line was to transfer condensates from the tank farm to the crib.

2.2 OPERABLE UNIT DESCRIPTION

The 200-BP-1 Operable Unit encompasses approximately 25 acres in the north-central portion of the Hanford Site. The waste management units (cribs) are located within approximately 4 acres in the eastern portion of the 200-BP-1 Operable Unit (Figure 1). A complete description of this operable unit can be found in the work plan.

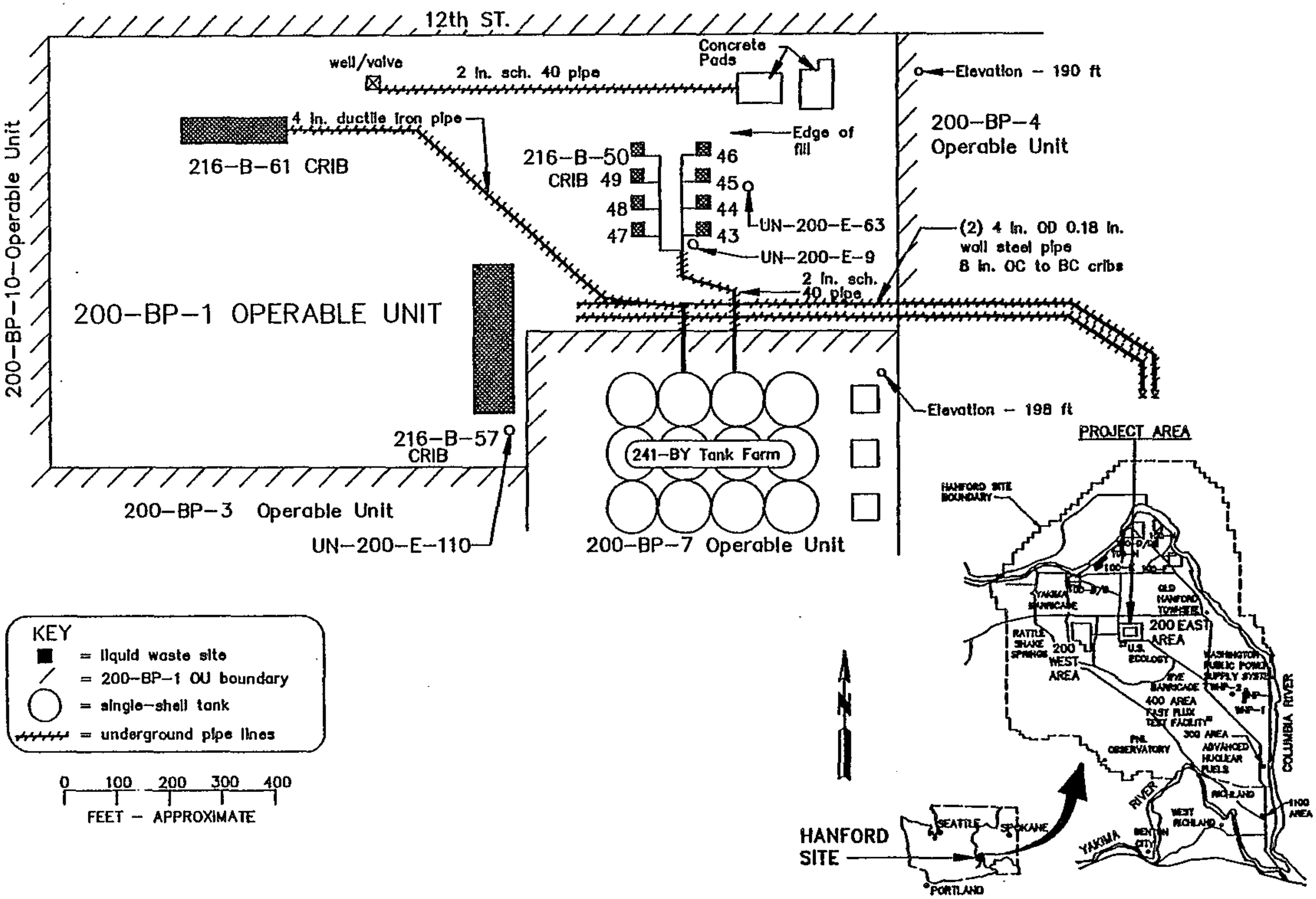


Figure 1. 200-BP-1 Operable Unit and Vicinity Map.

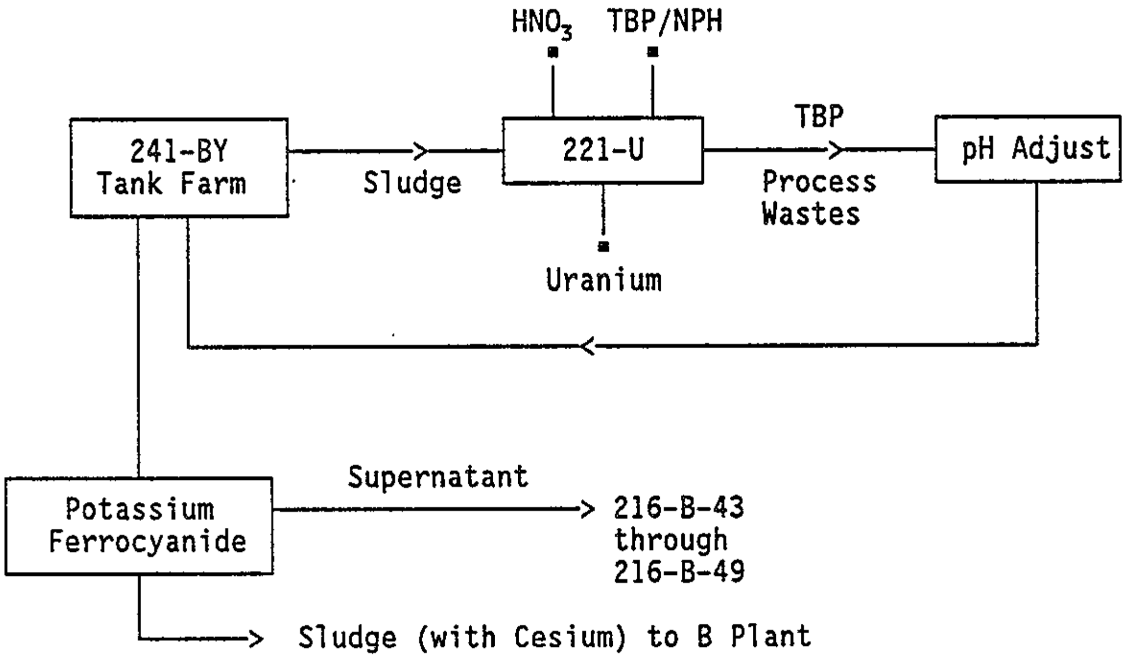
Liquid wastes disposed in the 200-BP-1 Operable Unit cribs and unplanned releases were the result of the tributyl phosphate (TBP) or in-tank solidification (ITS) processes associated with single-shell tank (SST) farm operations. The TBP waste was scavenged by potassium ferrocyanide to precipitate out cesium. The supernatant was decanted to cribs in the operable unit. The ITS process heated tank waste and, in the process, generated condensates. These condensates were also disposed in cribs in the 200-BP-1 Operable Unit. The history of use of the 200-BP-1 waste management unit (cribs) and a generalized flow diagram of these three processes are shown in Table 1 and Figure 2, respectively.

Table 1. History of Operations of Waste Management Units in the 200-BP-1 Operable Unit.

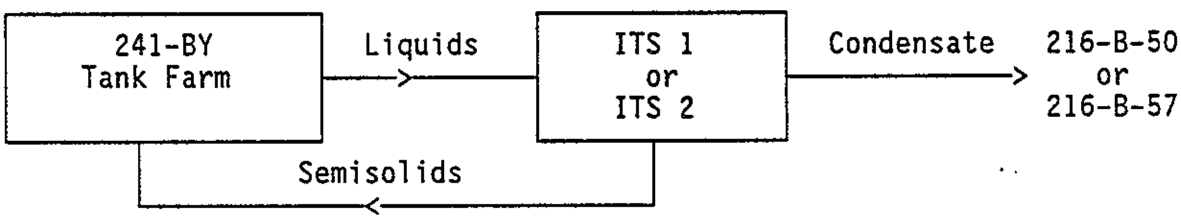
Crib No.	Volume disposed x 10^6 L	Period of use/purpose
216-B-43	2.1	1954 - TBP scavenged supernatant waste
216-B-44	5.6	1954-55 - TBP scavenged supernatant waste
216-B-45	4.9	1955 - TBP scavenged supernatant waste
216-B-46	6.7	1955 - TBP scavenged supernatant waste
216-B-47	3.7	1955 - TBP scavenged supernatant waste
216-B-48	4.1	1955-57 - TBP scavenged supernatant waste
216-B-49	6.7	1955 - TBP scavenged supernatant waste
216-B-50	54.8	1965-1974 - ITS condensate
216-B-57	84.4	1968-1973 - ITS condensate
216-B-61		--No record of use

Figure 2. Generalized Flow Diagram of Process Wastes in the 200-BP-1 Operable Unit.

I. Uranium Recovery Process and Cesium Scavenger Process (1952-1958)



II. In-Tank Solidification Process (1965-1974)



A list of the known and suspected analytes that were detected in the vicinity of the 200-BP-1 Operable Unit and the estimated quantities of waste disposed to the various cribs are shown in Tables 2, 3, and 4, respectively.

Table 2. Parameters of Interest to the 200-BP-1 Operable Unit (from DOE-RL/88-32).

Selenium	^{3}H	total U
Nitrate	^{90}Sr	^{106}Ru
Sulfate		total beta
Ferrocyanide	^{137}Cs	total alpha
Bismuth	^{240}Pu	
Free cyanide		
Total cyanide		
Phosphate		

Table 3. Estimated Chemical Waste Quantities Discharged to Cribs in the 200-BP-1 Operable Unit (from DOE-RL/88-32).

Chemical	Quantity[1] (kg)
Sodium	2,650,500
Nitrate	6,501,500
Sulfate	469,000
Phosphate	332,000
Ferrocyanide	18,900
Ammonium nitrate	10,000
Ammonium carbonate	21,000

[1]Trace quantities of paraffin hydrocarbons and tributyl phosphate not included.

Table 4. Estimated Radionuclides Inventory* to Cribs in the 200-BP-1 Operable Unit (from DOE-RL/88-32).

Radionuclides	Quantity (Ci) (Decayed to April 1986)
^{3}H	2,499
^{90}Sr	6,054
^{137}Cs	2,092
^{60}Co	0.4490
^{239}Pu	4.0457
^{240}Pu	1.0918
^{238}U	0.1806
^{106}Ru	0.00009
Total beta	16,179.2
Total alpha	<0.000005

*An unknown quantity of ^{99}Tc not included.

3.0 DESCRIPTION OF ALTERNATIVES

The alternatives evaluated in this study have been divided into two sets: (1) alternatives considered for penetrating underground pipelines and (2) alternatives considered for detecting leaks from underground pipelines.

3.1 PIPE PENETRATION

The underground piping in the 200-BP-1 Operable Unit is buried under approximately 2 to 5 ft of soil. Currently, the condition of the pipelines is unknown; it is not clear if the pipes have been sealed or valved off. There are no known easily accessible entry points into the interior of the pipeline. To determine whether there are leaks in the pipeline, it will be necessary to gain access to the pipe interior and ensure that all access points are closed or can be closed. Sections 3.1.1 and 3.1.2 describe how access to the interior of the pipe can be accomplished and/or how the pipe can be isolated for testing purposes.

3.1.1 Standard Practice Method

There are a number of conventional methods to gain entry into an underground piping system including addition of valves, capping off an existing line, and installing fittings such as elbows and tees. The standard practices for gaining access to piping and installing such devices are labor intensive and involve both hand and power tools. These include the following:

- Powered metal-cutting saws
- Hand-operated roller pipe cutters
- Electric- or air-operated drills
- Gas-fired cutting torches.

Because these standard practices could expose both workers and the environment to the potentially hazardous contents of the pipeline, another safer pipe penetration alternative was evaluated by this study. This is discussed below.

3.1.2 Hot Tapping Method

Specialized equipment has been developed to "hot tap" to an existing line. Hot tap is a term used when a line in which access is to be gained is operating under pressure, contains fluids that must not be spilled or gas that should not leak, or in a pipeline that cannot be shut down while the access is being constructed. Hot tapping is used extensively when pipeline operations must be maintained while the piping is being altered. The hot tap method can be applied for inserting valves, draining or sampling pipe contents, plugging pipe, and pressurizing lines.

The three most common methods for hot-tapping are described below.

1. One direction line stopping is used for plugging a line pressurized from one direction only and is used to isolate piping systems for repairs, alterations, or relocations. The procedure begins with a hot tap with the tapping fitting provided with a special outlet so the valve may be recovered. In addition to the hot tap equipment, the line stop machinery consists of a stopping head inserted by an actuator. After the stopping operation is finished and the head removed, the special outlet receives a closure plug to seal the branch of the hot tap fitting, allowing the temporary valve to be removed (Figure 3).

2. Addition of connections for tapping is used for making a connection to existing piping or vessels while that existing system is operational. This method employs a drilling or tapping machine, a full-ported valve and a pressure-cylinder-type fitting attached to the existing system (Figure 4).

3. Sure-stop sealing uses a cylinder-wedge stopper for a positive mechanical seal (Figure 5). The positive seal provides a mechanically wedged seal to allow new sections of pipe to be pressure tested between stoppers and by providing a machined edge-type seal, eliminating problems related to any "crud" that could remain in the pipeline.

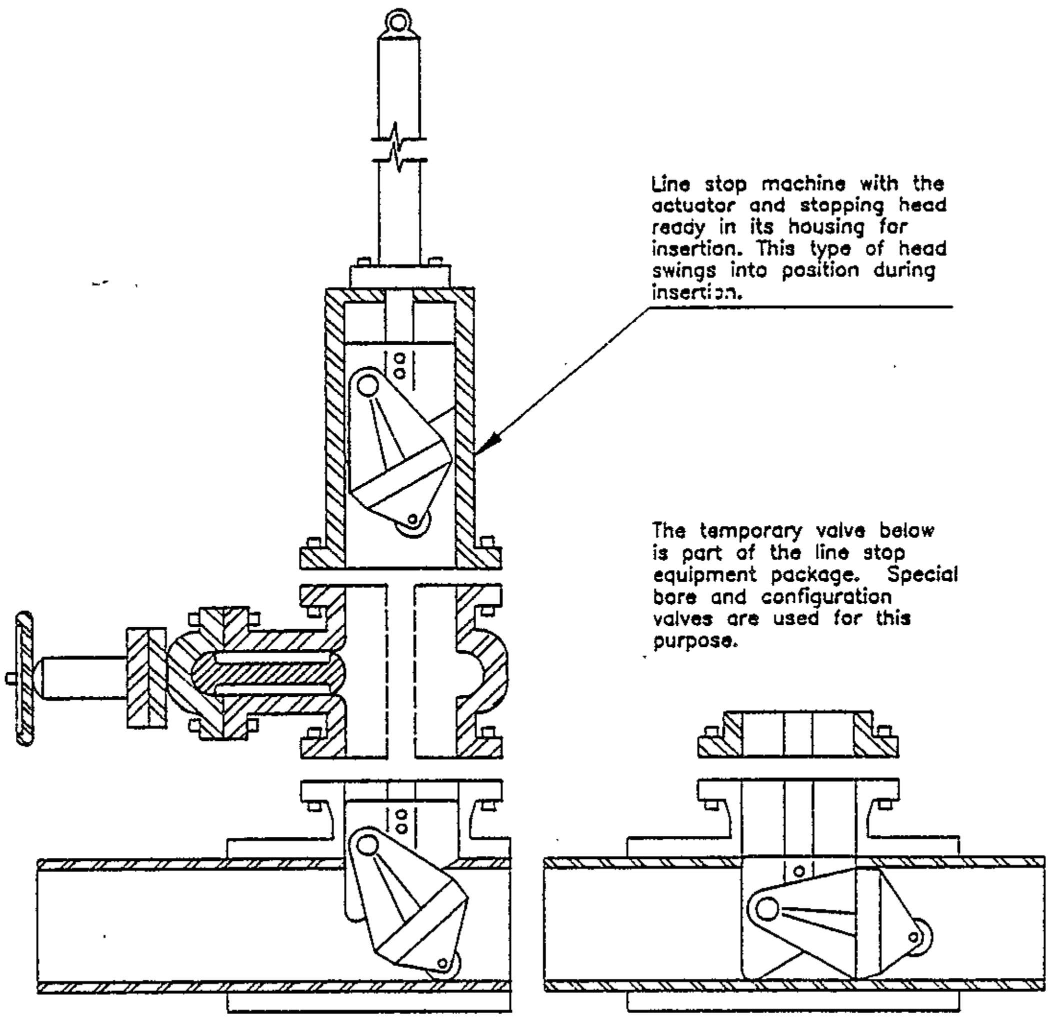
These methods are commonly used in specialized industries such as chemical plants, refineries, nuclear plants, and steam plants. Common to these industries is the fact that the access to pipelines can be made with the system remaining in operation during and after the pipe penetration is made. This enables the surrounding environment and personnel to be protected from any leaks or spills during the operation.

3.2 LEAK TESTING

A discussion of the leak testing/detection methods and a description of details necessary to compare the alternatives are provided in this section. The following options were considered as possible means to determine the integrity of the pipelines of concern in the 200-BP-1 Operable Unit:

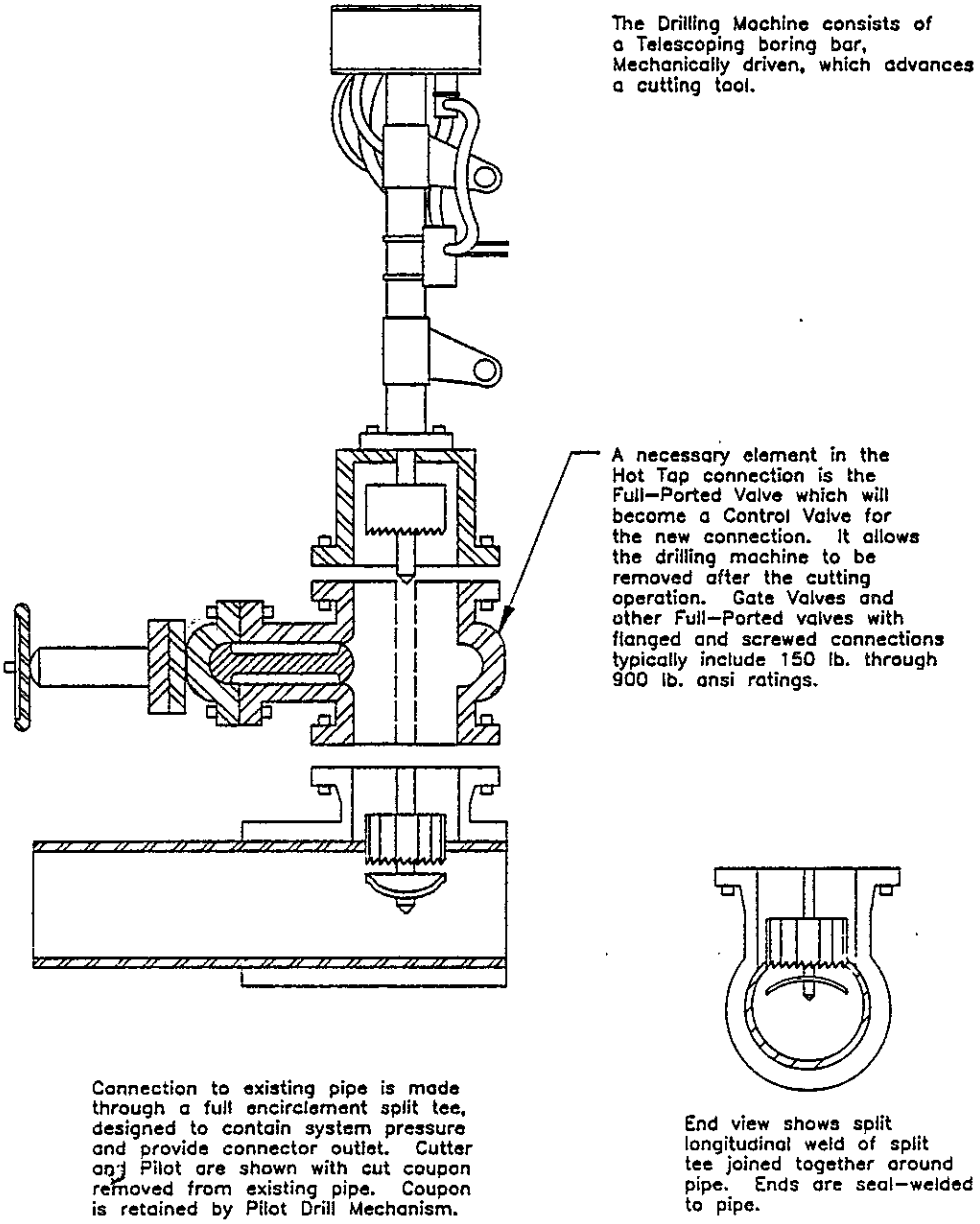
- Liquid dye
- Camera study
- Nondestructive tests
- Air pressure
- Tracer gases (three gases evaluated).

Figure 3. Schematic of the One-Direction Line Stopping Method of Hot Tapping.*



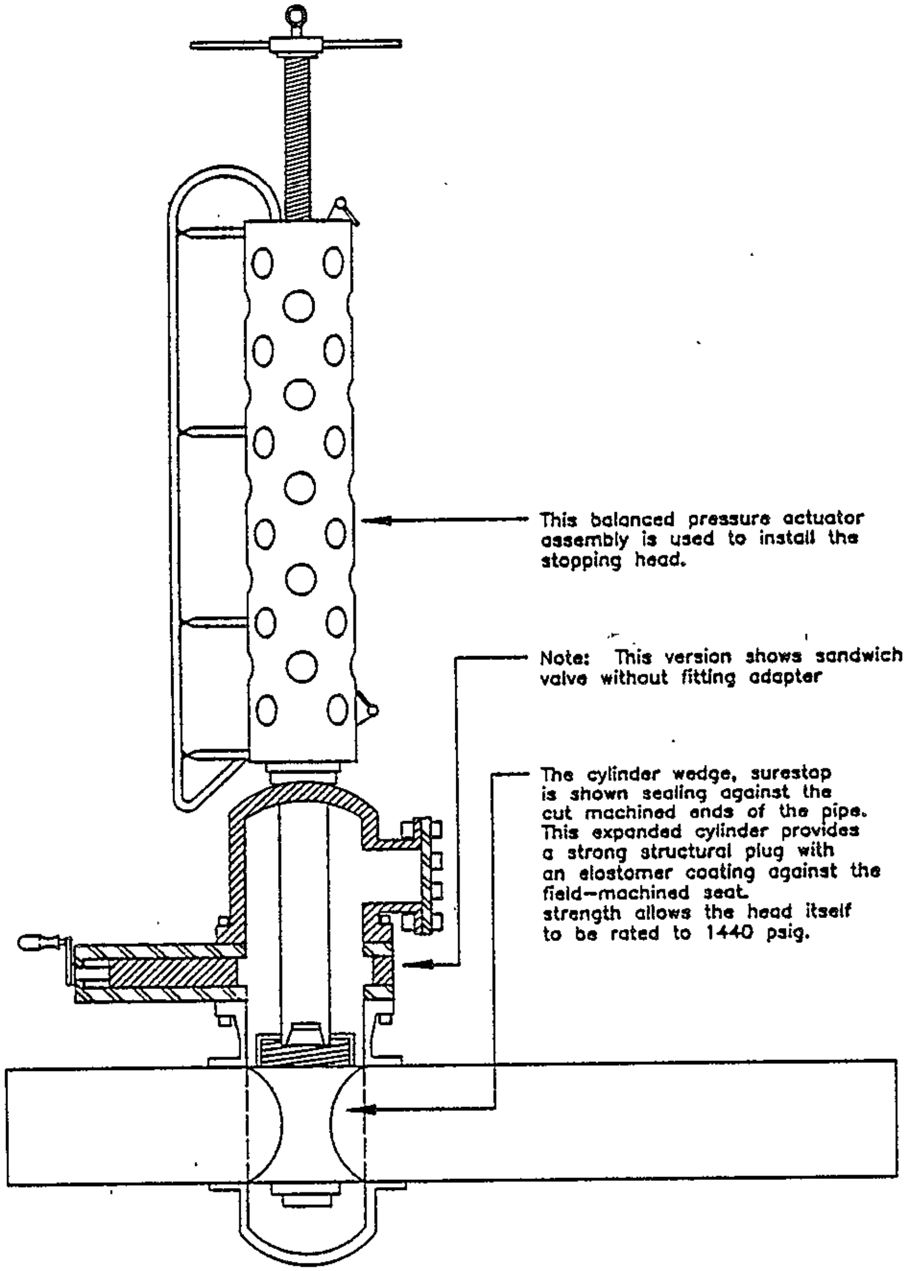
*This drawing was reproduced from literature provided by International Piping Services Company (IPSCO) USA.

Figure 4. Schematic of the Additional Connections Method of Hot Tapping.*



*This drawing was reproduced from literature provided by International Piping Services Company (IPSCO) USA.

Figure 5. Schematic of the Sure Stop Method of Hot Tapping.*



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Each option is described in detail below. For each of these test methods, the leak detection evaluation will determine pipeline integrity conditions existing on the test date.

Considerable detail is provided regarding tracer gases since they may be most applicable in detecting leaks in this study.

3.2.1 Liquid Dye

A liquid dye test may be used to determine pipeline integrity. This method uses water and a small volume (<8 oz) of red rhodamine dye. The dye is mixed with the water and then pumped into the pipeline where sufficient pressure (about 5 lb/in.^{2}) is maintained. A visual observation of the pipe exterior as well as pressure documentation is performed over a 4-h time period. The pipe integrity is determined by pressure drop over time. The leak locations are determined by visual inspection for discoloration of surrounding soil. The method requires excavation, use of a pump and mix tank, and creates an additional wastestream to be managed.

3.2.2 Camera Study

A camera study may be used to determine pipeline integrity. In using this study the pipeline would require total excavation to provide maximum external lighting and accessibility. Both ends of the pipeline would require plugging to minimize light interferences. This technique is only viable for pipe diameters over 4 in. since cameras available for this testing are greater than 2-1/2 in. dia. Any scaling or corrosion within the pipe may eliminate the use of cameras for the 4-in. pipe.

There are several camera types available to perform leak detection. One type of camera produces a one-dimensional line scan of the pipeline. A pulley and mount system is used to rotate the camera and traverse the pipeline. The camera consists of an image sensor that measures differences in lightness and transmits the signal to a microprocessor to flag the operator of any pipe flaws.

Another camera type with lighting produces a continual picture of the internal characteristics of the pipeline. The cameras transmit the image to a line viewing station and secure the picture on tape for study and record keeping. A backup camera would be required for each pipeline tested.

3.2.3 Nondestructive Tests

Nondestructive test methods generally do not require the pipelines to be penetrated; however, full excavation of pipelines is usually required, thereby potentially increasing worker safety concerns. A highly qualified inspector is also usually required. Even with a highly trained inspector, small leaks can go undetected.

Nondestructive methods have been practiced in the industry for many years. Five nondestructive methods are discussed below. However, for evaluation purposes, these were considered as one alternative: visual inspection, magnetic particle testing, bubble testing, ultrasonic, and radioisotope.

Visual inspection is used to detect any surface discontinuities such as cracks and other porosities in the pipelines. Factors influencing the inspection include lighting conditions, age of the pipe, and pipe material and coatings.

Magnetic particle testing uses an induced magnetic field in a localized area of the pipeline. A magnetic powder is applied and the flux leakage created by a surface discontinuity will attract the magnetic powder. The result is dependent on the direction of the magnetic field; false indications may result if magnetization is too high. This is used only for metal pipelines.

The principle of a **bubble test** is to locate a leak by applying a solution that will form bubbles when pipelines are charged with a pressurized gas. If no continuous bubble formation is observed, the pipe is considered acceptable. Particular attention is given to the flanges, seams, and valve connections.

The **ultrasonic** method may be used to determine the wall thickness of a pipeline and may also detect surface or subsurface discontinuities. This method uses an ultrasonic wave, which is induced at the surface of the pipeline and then propagates through the pipe wall. The wave is reflected back to the instrument when it encounters a discontinuity or wall boundary. The transient time of the wave is measured by a pulse echo instrument to calculate wall thickness.

The **radioisotope** method may be used to determine radiation levels of the pipelines and surrounding soil. A Health Physics Technician (HPT) takes readings to determine high levels of radiation that may signify a leak. This method is used when pipelines and surrounding soil do not contain radioactive materials above background levels. This is not the situation in the 200-BP-1 Operable Unit.

3.2.4 Air Pressure Test

An air pressure test performed on an underground piping system is referred to as a "tightness" test. Each end of the pipe section to be tested is sealed. In this instance, compressed air at 5 lb/in.^{2} would be applied to the pipe system and held there for 3 h to reach equilibrium with the surrounding soil. Following this time period, pressure data would be collected for a minimum of 1 h. If the pressure fluctuates more than approximately ±0.2 lb/in.^{2}, the line would be considered leaking. The pressure difference criteria are variable due to line size and line operating pressure. The documented pressure difference over time converts to a total leak rate. The air pressure test does not locate the area of the leak; it only documents line tightness and total leak rate.

3.2.5 Tracer Gases

3.2.5.1 Freon Tracer Gas

The use of a tracer gas for leak detection of underground piping functions according to the principle of gas diffusion. Tracer gas will diffuse out through piping defects and spread throughout the surrounding soil where it can be detected.

In selecting viable tracer gases, the tracer gas criteria below were considered.

- Tracer gas used should be chemically inert, nonflammable, nontoxic, noncorrosive, and low density.
- Selected gas should distribute itself evenly through any remaining product and be easily and specifically detected by a monitoring device.
- Time required to detect tracer gases after permeating through soils adjacent to pipelines should be reasonable (less than 1 to 2 wk).
- Tracer gas must be readily available and relatively inexpensive.

Freon can be used as a tracer gas because it is readily available, inexpensive, and would be unique to the pipelines within the scope of this study. However, most freon has been shown to be harmful to the earth's ozone layer and may be undesirable.

The use of freon as a tracer gas begins with pressurizing a sealed section of underground piping with freon gas. If the section maintains pressure, it is sealed and pressure is recorded as a function of time (approximately 2 to 3 h). If pressure is maintained within limits after corrections are made for thermal equilibrium, the section of pipeline will be considered tight with no leaks. If pressure is lost during the 3-h equilibrium test or if it fails to pressurize, it will be considered to have leaks or defects.

When freon is used as a tracer gas to determine leak locations, soil probes must be installed along the tested pipeline so soil gas samples can be collected and analyzed. The placement and depth of soil probes are affected by the piping configuration, mobility of the tracer gas, the permeability of the surrounding soil, and type of monitoring device. Soil probes are placed as close to the pipeline as technically feasible (<2.5 ft), with one probe placed every 10 ft in sand or gravel backfill and one at each pipeline joint (if known). If backfill consists of less permeable soils like clay and silt, the number of probes should be doubled with 5-ft spacings. The ideal depth of the probes would be a depth equal to the base of the pipeline. The anticipated depths at the 200-BP-1 Operable Unit for soil probes is 2.5 to 5.0 ft.

A detection system plan is required for proper placement of soil probes. The number, location, and depth of pipe runs must be identified to ensure a functional detection system. Metal detectors, ground penetration radar, and existing pipeline schematics all may be used to identify the existing pipeline network. After the pipeline runs have been identified and marked, the probes can be installed.

A typical soil probe is usually less than 2 in. in diameter to facilitate installation and reduce costs. However, larger diameter soil probes may be installed if needed for reasons other than soil gas sampling. The probe may be polyvinyl chloride (PVC), stainless steel, or galvanized steel. Method of placement is either by boring a hole in the ground to the proper depth and inserting the probe or by driving the probe down to the proper depth.

Once the probes have been installed, freon is introduced into the section of pipeline to be tested. A diffusion time of 2 to 3 wk must be allowed for the tracer gas to migrate outward through leaks into the soil, assuming the backfill material around the pipelines was natural overburden. After the proper diffusion time, soil gas samples are collected from each of the probes and analyzed by gas chromatography (GC). This detection method uses a flame detector to detect the freon in the sample. The freon peak height corresponds to the detected concentration. Either portable GC equipment or laboratory GC equipment is acceptable for analyzing freon in samples.

Calibration of the GC is performed using standard laboratory methods. Quality Assurance/Quality Control (QA/QC) standards and spikes are used in conjunction with the tracer gas analysis.

Data interpretation is critical in the completion of the freon leak detection survey. Assurances would be required that the test followed the specified protocol for the following:

- Determination of the number of tests that were to be run
- Length of each test
- What value constituted a leak
- That all calculations were performed correctly.

These data should provide a determination of pipe tightness and provide nonspecific leak locations ±10 ft where soil probe spacing is 10 ft. Because of the nonspecific determination, confirmation of the leak location should be performed. This requires additional probe installations in the area in which freon gas was detected and repeating the test.

3.2.5.2 Halon Tracer Gas

Halon, as a tracer gas, can be used for leak detection. Halon gas is readily available and inexpensive. It is relatively inert, nonflammable, and non-corrosive. Halon is unique to the surroundings within the scope of this study, has a relatively short diffusion time, and is easy to detect and analyze. The preparation and testing protocol for halon is the same as described in the previous section for freon.

3.2.5.3 Helium Tracer Gas

Helium has several properties that make it ideally suited for tracer gas testing. It is chemically inert, nonflammable, nontoxic, noncorrosive, and has a very low density. It is very easy to detect, has a very short diffusion time, and is unique to the environment in this operable unit.

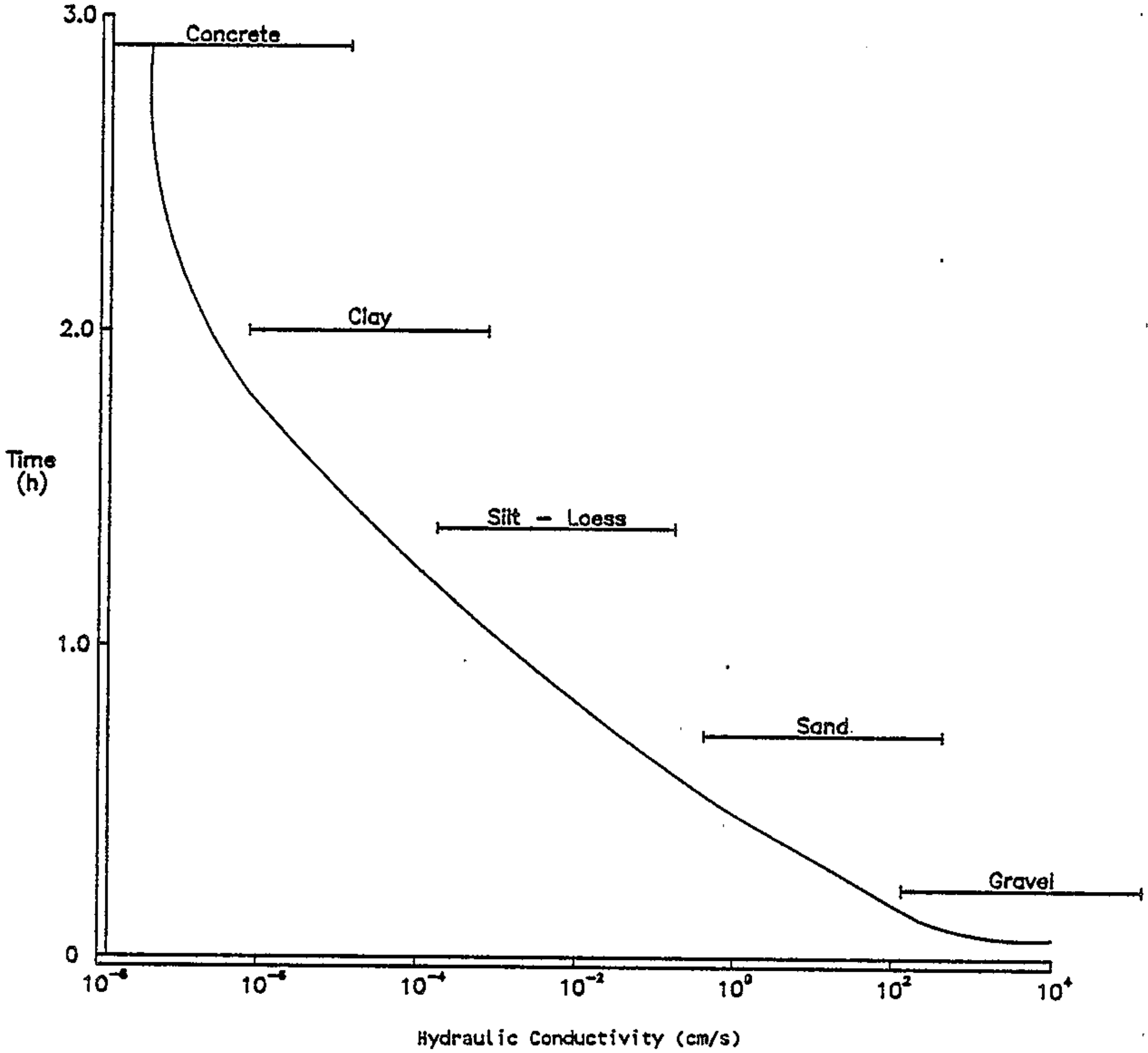
As with air, freon, and halon, helium can be used to perform a pressure test on the pipeline. If pressure is lost during the test, the section of pipe will be considered to have leaks or defects.

A portable helium detector is used to locate the leak. The detector uses a sensor block that relies on changes in thermal conductivity. A separation column draws in an air sample, and the components are reported as they pass over the sensor. Each component has a unique thermal conductivity, thereby allowing the sensors to be specific to helium. Helium detection is in the range of 0.01 to 1.00 of concentrated helium (100%). Figure 6 shows the migration rate of helium through a variety of soil types.

To locate a leak, ambient air samples are collected by the sampler immediately above the ground surface in 2-ft increments. Samples are collected above the entire length of the tested pipeline. If helium is detected over a certain portion of the buried pipeline, the leak can be located within 6 in. by collecting several readings in the vicinity of where helium was first detected.

Circumstances unique to the 200-BP-1 Operable Unit pipelines require modification to the test procedure described above. For example, if one end of a section cannot be sealed because of radiological or other concerns, a tightness test could not be performed using pressure. However, a hand-held detector can still locate leaks along the pipeline. Helium can be slowly released into the open-ended pipeline and will still diffuse through holes and defects. The same procedure can also be used when a large hole or defect will not allow pressurization.

Figure 6. Helium Migration Rates in Various Soils.



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4.0 EVALUATION OF ALTERNATIVES

The alternatives for the detection of leaks in the 200-BP-1 Operable Unit were discussed in detail in the previous section. Weighted criteria were used to evaluate each of the alternatives to arrive at a preferred alternative. Five criteria were selected for use in this study and weighted from 2.0 to 4.0, with 4.0 being the most important. The criteria and their weighting factors are shown below.

Criteria 1 through 5: Weighting Factors

Total Score	Weighting Factor	Criterion
20	4.0	Environmental Protection
20	4.0	Worker Safety/ALARA
15	3.0	Ease of Use
12.5	2.5	Cost
10	2.0	Availability
77.5		

The alternatives were evaluated, in a matrix format, against the criteria and a raw score from 0 to 5 was assigned. Descriptions of raw scores are addressed under each criteria. Raw scores were then multiplied by a weighting factor from 2.0 to 4.0 to determine an overall alternative score. The criteria and scoring for the two major subsections, pipe access and leak detection, are discussed in the following subsections.

4.1 EVALUATION OF PIPE PENETRATION

The rationale for the raw score ratings for all of the criterion relating to pipe access is discussed in the following sections.

4.1.1 Environmental Protection

Protection of the environment, including regulatory factors and the minimization of waste, was judged to be an important criteria in the evaluation of alternatives. Environmental protection criteria took into consideration a number of factors including the potential for spills of hazardous/radioactive material to the environment, acceptance of the alternative to regulatory agencies, and the necessity for producing wastes resulting from preparation of the pipe for leak detection tests.

Variations on these factors were also considered. For example, a pipe cutting or penetration method that would release the entire amount of an accumulated material was ranked lower than one which could bleed off a small quantity first to determine if any accumulated material in the pipeline existed. Another example of this degree concept is the relative volume of secondary wastes generated. The raw scores that were assigned to this criteria are below.

Criteria 1: Environmental Protection

Raw Score	Description
5	No environmental/regulatory impacts; no additional wastes generated.
4	Low potential for environmental or regulatory impacts; no additional wastes generated.
3	Low potential for environmental or regulatory impacts; additional wastes may be generated.
2	Moderate potential for environmental or regulatory impacts; additional wastes may be generated.
1	High potential for environmental or regulatory impacts; large volumes of waste may be generated.
0	Unacceptable environmental or regulatory impacts; large volumes of additional wastes may be generated.

Table 5 provides the matrix which compares the two pipe penetration alternatives against the raw and weighted scores associated with the environmental protection criteria.

Table 5. Environmental Protection Criteria Scores - Pipe Penetration Alternatives.

Alternative	Raw Score	Weight Factor	Weighted Score
Standard Practice	2.0	4.0	8.0
Hot Tap	4.0	4.0	16.0

4.1.1.1 **Standard Practice Method.** The standard practice method of pipe access as it pertains to the environment refers to the conventional method of penetrating or accessing the underground pipe in the plumbing industry. This procedure, because of the method, requires the pipe or fitting be opened to the environment prior to installing tapping valves, plugs, stops, etc. This creates a moderate potential for environmental impacts and additional waste generation. This negative factor resulted in the 2.0 rating for the environmental protection evaluation.

4.1.1.2 Hot Tap Method. The hot tap method of pipe access described in Section 3.1.2 enables the penetration of the underground pipe at pre-selected locations (2.5 to 5.0 ft deep) without exposing the interior contents to the environment. This feature is the primary reason for the development of the hot tap technique. A procedural violation of the installation of the tap or defective hardware from the manufacturer would be two remote possibilities for leaks to the atmosphere. Training for and testing of the installation and valves, respectively, will minimize this possibility. A 4.0 rating was given to this method based on its ability to maintain the operational integrity of the underground system during the penetration.

4.1.2 Worker Safety/As Low As Reasonably Achievable

Protection of workers who must excavate, penetrate, and test pipes was also judged to be an important factor in the detection of leaks in the 200-BP-1 Operable Unit. Evaluation of alternatives for these criteria included a wide range of safety-related items including excavation safety, contamination control, health physics standards (e.g., as low as reasonably achievable [ALARA]), dose consequences, and flammable gas explosion potential. Because of its importance, a weighting factor of 4.0 was assigned. As with the previous criteria, degrees of potential consequences were considered. For example, if two pipe penetration methods were equally effective, but one required that personnel have more hours of exposure to excavated pipelines, it ranked lower than the other alternative.

The raw scores assigned to this criteria are below.

Criteria 2: Worker Safety/ALARA

Raw Score	Description
5	No expected safety hazards or personnel exposure.
4	Low potential of safety hazards or personnel exposure.
3	Low to moderate potential of safety hazards or personnel exposures.
2	Moderate to high potential of safety hazards or personnel exposure.
1	High potential of safety hazards or personnel exposure.
0	Unacceptable potential safety hazards or personnel exposure.

Table 6 shows the two pipe penetration methods ranked by the worker safety/ALARA criteria.

Table 6. Worker Safety/As Low As Reasonably Achievable Criteria - Pipe Penetration Alternatives.

Alternative	Raw Score	Weight Factor	Weighted Score
Standard Practice	1.0	4.0	4.0
Hot Tap	4.0	4.0	16.0

4.1.2.1 Standard Method of Pipe Access. The standard method of pipe access is important relative to worker safety/ALARA ranking criteria. This alternative is labor intensive and allows the interior of the underground piping system to be exposed to the atmosphere. An additional safety factor is the requirement of the pipe penetrations or tapping to be performed in a trench up to 5 ft below grade. The excavation cave-in hazard can be reduced by using standard shoring safety procedures for trenches in excess of 4 ft below grade. Finally, as stated in previous sections of the report, the contents of the underground piping systems can be radioactive and could contain flammable gases. The score of 1.0 was assigned to this method because of the inherent nature of the procedure exposing the contents of the piping system to the worker.

4.1.2.2 Hot Tap Method of Pipe Access. The hot tap method of pipe access enables the worker to access or penetrate the underground system without exposing the contents to the environment or workers. As described in Section 3.1.2, this technique will allow a variety of tapping, plugging, valving, and other methods without spilling or leaking the contents of the system. The possibility of exposure is remote and is related to the technical procedure of applying the hot taps and how the procedures are followed during installation. The other possibility for leaks is if the hardware has a manufacture defect. All hardware and fittings should be pressure checked prior to installation to minimize this condition. The excavation cave-in hazard can be reduced by using standard shoring safety procedures for trenches in excess of 4 ft below grade. A score of 4.0 was assigned to this method.

4.1.3 Ease of Use

The relative ease of use of installed hardware, such as valves and taps, was deemed important for this study and was assigned a weighting factor of 3.0. This ease of use relates to the overall minimum effort, technical training, and supervision required. Included in this criteria evaluation were analyses of both new and future application. For example, two valves installed equally would not necessarily be ranked equally if one valve required less preventive maintenance or had the potential to become nonfunctional in the field over time. Also important in this criteria evaluation was the degree of personnel training required to use the hardware.

The raw scores assigned to this criteria are below.

Criteria 3: Ease of Use

Raw Score	Description
5	Hardware that is extremely easy to use; onsite personnel have previously used for similar applications. Personnel will require minimal or no additional training.
4	Hardware and material that are commonly used for similar applications but on-site personnel may not have used them previously. A minimal level of training may be required.
3	Hardware and material that are commonly used for special applications but are not common knowledge to onsite personnel. They require a minimal degree of training.
2	Hardware and material that are commonly used for special applications, but are not common knowledge to onsite personnel. Low to moderate training is required.
1	Hardware and material that are not commonly used. Moderate to high levels of training is required.
0	Unacceptable ease of use. Hardware and material have not been used for any similar applications.

Table 7 provides a comparison of pipe penetration methods using the ease-of-use criteria.

Table 7. Ease-of-Use Criteria - Pipe Penetration Alternatives.

Alternative	Raw Score	Weight Factor	Weighted Score
Standard Practice	2.0	3.0	6.0
Hot Tap	3.0	3.0	9.0

4.1.3.1 Standard Method of Pipe Access. The standard practice method for pipe access is labor intensive compared to the other method. This additional time to penetrate and add fittings to the underground piping is necessary because of the hand work and supervision required for the task. Conventional methods and tools are, by nature, less precise and increase the likelihood for worker judgment error. The need for containments around the pipe and greater clearance requirements around the pipe in a confined excavation makes this method complicated. A score of 2.0 was assigned to this method because of the high likelihood of leaks and the difficulty of work in this confined underground area.

4.1.3.2 Hot Tap Method. The hot tap method of accessing pipe allows the penetration of piping with a high quality of installation because the procedure has been designed through precisely engineered techniques and hardware. This procedure has been formulated to enter piping systems without interrupting the flow or operation of the system. This factor requires that the work be done accurately, quickly, and correctly the first time. Inherently, this method, using power cutting tools and pre-engineered saddle clamps, will allow installation ease and a relatively risk-free job from a leak or spill standpoint. This technology enables the field worker to access a confined underground piping system with comparative ease. A score of 3.0 was assigned to this method.

4.1.4 Cost

The combined operating and capital costs of each alternative was considered a valuable evaluation criterion. A weighting factor of 2.5 was assigned.

The raw scores assigned to this criteria are as follows:

Criteria 4: Cost

Raw Score	Description
5	No costs incurred
4	Minimal costs required
3	Costs related to average commercial work
2	Costs approximately 50% higher than like commercial work
1	Costs 200% to 400% higher than like commercial work
0	Unacceptably high cost.

Table 8 provides a comparison of the pipe penetration methods using the cost criteria. (Specific cost data can be found in Appendix A.)

Table 8. Cost Criteria - Pipe Penetration Alternatives.

Alternative	Raw Score	Weight Factor	Weighted Score
Standard Practice	2.0	2.5	5.0
Hot Tap	1.0	2.5	2.5

4.1.4.1 Standard Practice Method. The standard practice method of pipe access can be accomplished at a relatively moderate to low cost if installation is made by tradespeople in the conventional commercial or industrial environment. The working conditions at the Hanford Site will require more supervision, administration, and working time than in the conventional working environment. Examples of factors that increase the cost are the time required to enter and leave the area, the monitoring for a hazardous or radioactively contaminated environment, and the possibility of specially trained noncraftspeople doing the work. Based on the above considerations, a score of 2.0 was given to the cost evaluation of pipe access.

4.1.4.2 Hot Tap Method. The hot tap method of accessing pipe can be achieved in an efficient manner but the cost of hardware (boring tools, cutters, saddle clamps, and fittings) is higher than conventional tools and fittings. Because this pipe penetration method has not been used extensively at the Hanford Site, the time for additional personnel training would add to the costs. This method would also require special training in understanding the technical or administrative procedures as well as completing the actual installation, whether accomplished with onsite or offsite personnel. If the work is contracted to outside specialists, the hot tapping may be accomplished more efficiently; however, onsite worker training would be required to familiarize personnel with the Hanford Site environment and administrative procedures. In consideration of the above, a score of 1.0 was assigned.

4.1.5 Hardware and Equipment Availability

The availability of hardware to install pipe penetration equipment in pipelines of the 200-BP-1 Operable Unit was the fifth evaluation criteria considered. A weighting factor of 2.0 was assigned to this criteria.

The raw scores associated with this criteria are below.

Criteria 5: Hardware and Equipment Availability

Raw Score	Description
5	Hardware/equipment in use at the Hanford Site or other DOE facilities; equipment and materials available in the Northwest region of the United States.

4 Hardware/equipment in use in other similar applications; equipment and materials available in the Northwest.

3 Hardware/equipment in use in other areas of the United States but for different applications.

2 Hardware/equipment under development with only a few field-scale applications.

1 Hardware/equipment is theoretical only and has not progressed beyond the bench scale.

0 Not available.

Table 9 indicates the comparison of the two pipe penetration methods using the availability criteria.

Table 9. Hardware Availability - Pipe Penetration Alternative.

Alternative	Raw Score	Weight Factor	Weighted Score
Standard Practice	5.0	2.0	10.0
Hot Tap	3.0	2.0	6.0

4.1.5.1 Standard Practices Method. The standard practices method of accessing the underground piping system requires equipment, tools, and technical knowledge that are available on a local basis. The technology and methods are known and proven. This conventional approach to pipe penetration by cutting, drilling, inserting, and patching is well known in the pipe-fitting industry and competent craftspeople are available either onsite or local to the Hanford Site. Therefore, a score of 5.0 was given.

4.1.5.2 Hot Tap Method. The hot tap method of pipe access is a proven technology in the chemical and petroleum industries, and can be used for special applications similar to those found in the 200-BP-1 Operable Unit area. The hardware and tools are special and are available only from vendors specializing in this type of work. The pipe fittings are standard for the industry and can be purchased regionally. The installation work can be contracted outside to specialists of that type of pipe fitting. An outside contractor could also provide the tools, hardware, valves, and fittings for a complete turn-key job. Some vendors (located in the Midwest or Southwest United States) are familiar with the nuclear environment and working conditions. Therefore, a score of 3.0 is assigned to equipment and hardware availability.

4.2 LEAK DETECTION

The following sections discuss the rationale for the raw score ratings for the leak detection alternatives.

4.2.1 Environmental Protection

Regulatory acceptability or compliance and environmental impact may be a critical criterion for determining whether a leak detection alternative is viable. The environmental protection criterion took into consideration a number of factors including the potential for spills of material to the environment and the production of secondary wastes. This criterion was judged to be an important consideration; therefore, a 4.0 weighting factor was assigned.

The raw scores that were assigned to the criteria are below.

Criteria 1: Environmental Protection

Raw Score	Description
5	No environmental/regulatory impacts; no additional wastes generated.
4	Low potential for environmental/regulatory impacts; no additional wastes generated.
3	Low potential for environmental/regulatory impacts; additional wastes may be generated.
2	Moderate potential for environmental/regulatory impacts; additional wastes may be generated.
1	High potential for environmental/regulatory impacts; large volumes of additional wastes may be generated.
0	Unacceptable environmental/regulatory impacts; large volumes of additional wastes may be generated.

Table 10 shows the seven leak detection scores weighted against the environmental protection criteria.

Table 10. Environmental Protection Criteria - Leak Detection Alternatives.

Alternatives	Raw Score	Weight Factor	Weighted Score
Liquid Dye	1.0	4.0	4.0
Camera Study	4.0	4.0	16.0
Nondestructive	2.0	4.0	8.0
Air Pressure	4.0	4.0	16.0
Freon	0.0	4.0	0.0
Halon	3.0	4.0	12.0
Helium	4.0	4.0	16.0

4.2.1.1 Liquid Dye. Liquid dye tests meet minimum criteria for pipe integrity tests for the 200-BP-1 Operable Unit pipelines. However, a large volume of potentially radioactive water-dye mixture could be produced from each test and create a waste disposal concern. Accordingly, a score of 1.0 was assigned.

4.2.1.2 Camera. Although the diameter of the pipe may be a constraint, a camera test meets criteria for pipe integrity tests for pipelines in this operable unit. The only intrusion required would be pipe penetration to insert the camera. Accordingly, a score of 4.0 was assigned.

4.2.1.3 Nondestructive Test. Nondestructive inspections meet necessary criteria for pipe integrity. It would require that a large volume of potentially contaminated soil be removed to conduct the investigation since the entire length of the pipeline would require excavation. Accordingly, a score of 2.0 was assigned.

4.2.1.4 Air Pressure. An air pressure test is an acceptable method for pipe integrity testing. This method, as well as any other pipe pressurizing method, would require that precautions, such as a small high-efficiency particulate air (HEPA) filter, be used when bleeding off the excess pressure. This would prevent potential releases of entrained contaminants at the points of access. The entrainment and release of contaminants at leak points will not be a significant risk because of the rapid loss of velocity in the soil outside the pipe and the inert character of the gases that would not chemically bind or carry the contaminants. In addition, any small amounts carried by the gases would be insignificant compared to the larger volumes already in the soil from past leaks. This method would require minimal intrusion of the soil to install the required valve and piping system; accordingly, a score of 4.0 was assigned.

4.2.1.5 Freon Tracer Gas. This alternative uses freon gas that has been shown to be a hazard to the environment and human health. The EPA does not recommend the use of freon as a tracer gas. Therefore, a score of 0.0 was assigned to this alternative.

4.2.1.6 Halon Tracer Gas. Halon tracer gas has been shown to pose little threat to human health or the environment. However, the possibility exists during the installation of soil probes that contaminated soils may be brought to the ground surface if auger drilling techniques are needed to install the probes. Due to these possibilities, a score of 3.0 was assigned.

4.2.1.7 Helium Tracer Gas. As discussed in Section 3.2.5.3, helium gas as a tracer has a low potential for environmental impact and does not require soil probes; therefore, a score of 4.0 was assigned.

4.2.2 Worker Safety/As Low As Reasonably Achievable

Worker safety and the ALARA principles are based on the use of engineered barriers, time, and distance to ensure protection of personnel. Protective equipment and administrative controls serve as a secondary means for achieving protection.

The leak detection alternatives present potential for exposure to ionizing radiation or hazardous materials. Each alternative was evaluated according to the potential personnel exposure and worker safety considerations. This criterion was deemed important to the evaluation of leak detection alternatives and was, therefore, given a high weighting (4.0). The raw scores below were assigned.

Raw Score	Description
5	No expected safety hazards or personnel exposures.
4	Low potential of safety hazards or personnel exposures.
3	Low to moderate potential of safety hazards or personnel exposures.
2	Moderate to high potential of safety hazards or personnel exposures.
1	High potential of safety hazards or personnel exposures.
0	Unacceptable potential safety hazards or personnel exposure.

Table 11 presents the seven leak detection alternatives against worker safety and ALARA criteria.

Table 11. Worker Safety/As Low As Reasonably Achievable - Leak Detection Alternatives.

Alternative	Raw Data	Weight Factor	Weighted Score
Liquid Dye	2.0	4.0	8.0
Camera Study	2.0	4.0	8.0
Nondestructive	0.0	4.0	0.0
Air Pressure	4.0	4.0	16.0
Freon	3.0	4.0	12.0
Halon	3.0	4.0	12.0
Helium	4.0	4.0	16.0

4.2.2.1 Liquid Dye. The liquid dye test requires total excavation of the pipeline. While the liquid dye mixture is nonhazardous, the product mixture upon completion of the tests has a potential for radioactive exposure and worker safety during excavation. Accordingly, a score of 2.0 was assigned.

4.2.2.2 Camera Study. The camera study would require total excavation of the pipeline. In addition, the camera would require decontamination after each pipeline test was completed. Finally, a potential for personnel exposure and worker safety exists for this alternative. Because of these factors, a score of 2.0 was assigned.

4.2.2.3 Nondestructive. The nondestructive method would require total excavation of the pipeline. It would also require that an inspector be within inches of the pipe and in trenches underneath the pipe during the entire study. This method has an unacceptably high potential for radiation exposure and worker safety. Accordingly, a score of 0.0 was assigned.

4.2.2.4 Air Pressure. The air pressure test requires minimal excavation of soil. Air is a naturally occurring substance with no risk by contact. The handling of the compressed air requires minimal training and poses a low risk potential. Therefore, a score of 4.0 was assigned.

4.2.2.5 Freon Tracer Gas. Freon gas is a relatively inert gas that poses very little threat to the field workers upon contact. However, the compressed gas cylinders that contain the freon do pose a threat to worker safety. In addition, the installation of soil probes along the pipeline may increase radiation exposure as deeper soils are brought to the surface. Accordingly, a score of 3.0 was assigned.

4.2.2.6 Halon Tracer Gas. This alternative is nearly identical to the freon tracer gas method and, therefore, has the same safety hazards and personnel exposure potential; thus, a score of 3.0 was assigned.

4.2.2.7 Helium Tracer Gas. Helium, as a gas, poses very little risk because of contact; however, handling the compressed gas cylinders may pose a threat to worker safety. Helium detection is performed aboveground without soil probes. This results in lower potential for worker exposure compared to halon and freon. In consideration of these factors, a score of 4.0 was assigned.

4.2.3 Ease of Use

The relative ease of use of hardware and tracer gases was assigned a weighting factor of 3.0. The raw scores assigned to these criteria are below.

Criteria 3: Ease of Use - Leak Detection Alternatives

Raw Score	Description
5	Hardware and material are extremely easy to use; onsite personnel previously have used for similar applications. Personnel will require minimal or no additional training. Area of leak can be determined.
4	Hardware and material are commonly used for similar applications but onsite personnel may not have used previously. A minimal level of training may be required. Area of leak can be determined.
3	Hardware and material are commonly used for special applications but are not common knowledge to the operations technician. They require a minimal degree of training. Determines area of leak.
2	Hardware and material are commonly used for special applications but are not common knowledge to the operations technician. Low to moderate training would be required. Does not determine leak location.
1	Hardware and material are not commonly used. Moderate to high levels of training would be required. Does not determine leak location.
0	Unacceptable ease of use. Hardware and material have not been used for any similar applications. Does not determine leak location.

The majority of the leak detection options presented use state-of-the-art practices and equipment. State-of-the-art is defined as the current level of development and capability in terms of procedure, process, and technique in current practice. Five of the options presented may be applied with minimal (less than 1 wk) training, whereas the other two options would require years of experience to perform an adequate test. For all options, a 40-h hazardous waste course and radiation training are prerequisites to the leak detection training.

A higher score was assigned to an alternative that used hardware and gases that are easy to operate, require a minimal amount of additional training, and whose method determines the location of the leak. A reduced score was assigned to an alternative that used hardware and materials not commonly used and required a high level of training and expertise. Table 12 provides a comparison of each of the seven alternatives using the ease-of- use criteria.

Table 12. Hardware/Tracer Ease-of-Use - Leak Detection Alternatives.

Alternative	Raw Data	Weight Factor	Weighted Score
Liquid Dye	4.0	3.0	12.0
Camera Study	1.0	3.0	3.0
Nondestructive	1.0	3.0	3.0
Air Pressure	2.0	3.0	6.0
Freon	4.0	3.0	12.0
Halon	4.0	3.0	12.0
Helium	4.0	3.0	12.0

4.2.3.1 Liquid Dye. The liquid dye test uses water and a red rhodamine dye. Both materials are easily accessible and easy to use. The dye dissolves readily in water and creates a red stain on the soil in the proximity of a leak. Minimal training is required to perform the test. Based on these considerations, a score of 4.0 was assigned.

4.2.3.2 Camera Study. The camera study would require a high level of training expertise to perform. The required equipment is expensive and the results, at times, are subjective; therefore, a score of 1.0 was assigned.

4.2.3.3 Nondestructive. A nondestructive inspection of the pipeline would require a high level of expertise to perform; the inspector must be trained in use and interpretation of each of the testing results. Accordingly, a score of 1.0 was assigned.

4.2.3.4 Air Pressure. An air pressure test would require commonly used equipment located on the Hanford Site. The operation of this equipment would require minimal or no additional training, although training would still be required for test implementation and data interpretation. Unfortunately, this method does not determine the location of the leak and was therefore assigned a score of 2.0.

4.2.3.5 Freon Tracer Gas. Ordinary pressure gauges, regulators, and compressed gas cylinders are used to pressurize and regulate the pipeline pressure test. This equipment is readily available at the Hanford Site. In addition, soil gas samples collected from soil probes are standard procedure for environmental firms. Because of the ease of use, this method was assigned a 4.0.

4.2.3.6 Halon Tracer Gas. The halon tracer gas method is nearly identical to the freon tracer gas method; accordingly, a score of 4.0 was assigned.

4.2.3.7 Helium Tracer Gas. As with the freon and halon methods, ordinary pressure gauges, regulators, and compressed gas cylinders are used to pressurize and regulate the pipeline pressure test. This equipment is readily available at the Hanford Site. A portable helium detector may require a minimal amount of training to use. Accordingly, a score of 4.0 was assigned.

4.2.4 Cost

The fourth evaluation criterion, cost, was assigned a weighting factor of 2.5. The raw scores assigned to the criteria areas are as follows (specific leak detection costs can be found in Appendix B):

Criteria 4: Cost

Raw Score	Description
5	No cost incurred
4	Minimal cost
3	Only low cost would be required
2	Low to moderate cost
1	Moderate to high cost
0	Unacceptably high cost.

The combined cost (capital and operating) for performing a leak detection survey, when competing for limited resources with other waste management activities, may ultimately play the deciding factor as to whether an alternative is viable within the scope of activities to be performed at the Hanford Site. For example, an alternative that provided for a lower cost received a correspondingly higher score than an alternative that had a higher cost. The raw score was calculated by assigning a score of 0 to the most costly alternative--camera study--and assigned a score of 5 to the least costly alternative--air pressure test. A straight line drawn between these two points produced a slope of (145-440)/5 or 20 (Figure 7). Accordingly, the raw scores for the alternatives would fall on the line and were calculated as follows:

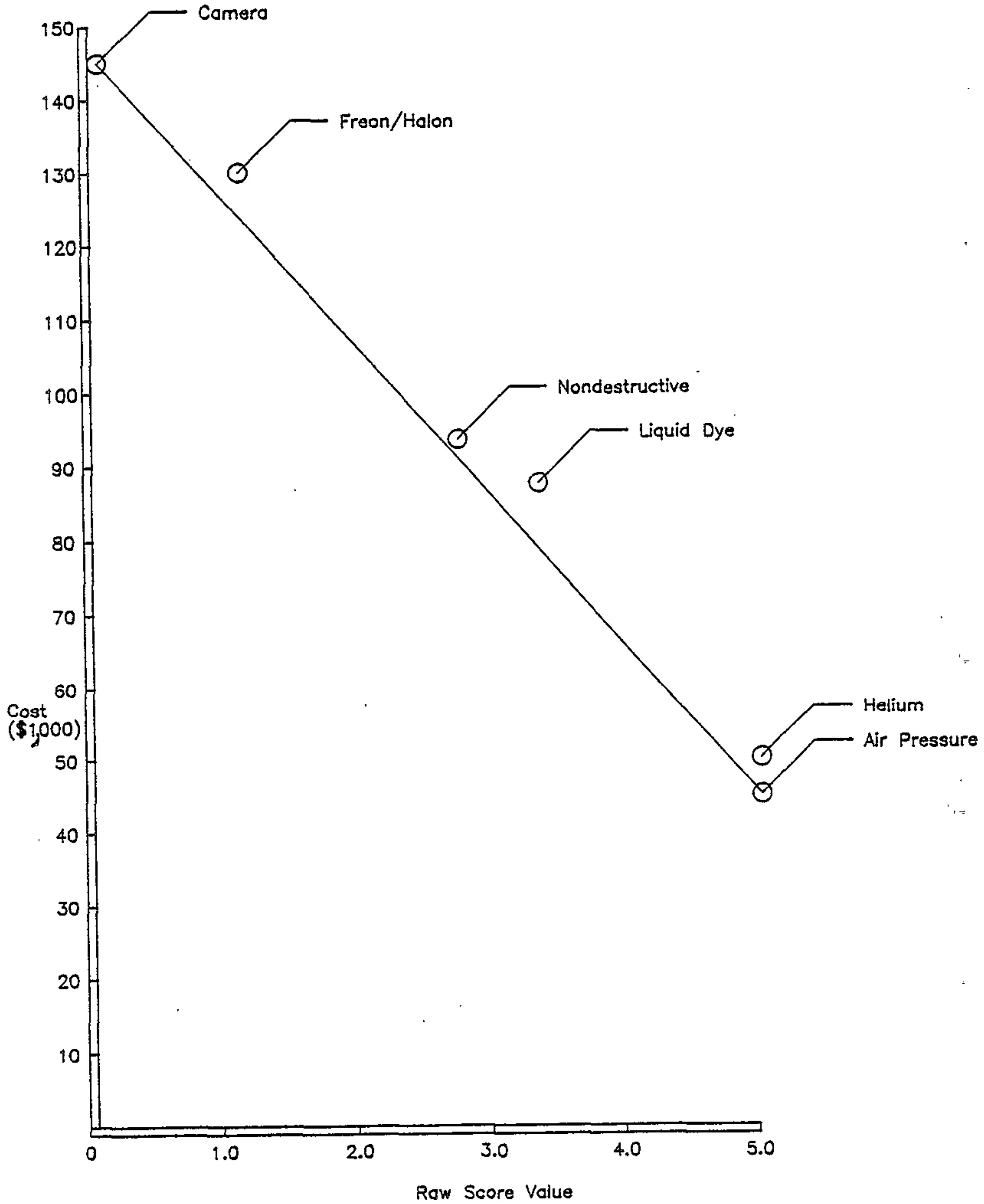
$$\text{Raw score} = (145 - \text{alternative cost})/20.$$

Table 13 provides a comparison of each of the seven alternatives using the cost criteria.

Table 13. Cost Comparison - Leak Detection Alternatives.

Alternative	Raw Data	Weight Factor	Weighted Score
Liquid Dye	3.0	2.5	7.5
Camera Study	0.0	2.5	0.0
Nondestructive	2.0	2.5	5.0
Air Pressure	5.0	2.5	12.5
Freon	1.0	2.5	2.5
Halon	1.0	2.5	2.5
Helium	5.0	2.5	12.5

Figure 7. Costs Associated with Leak Detection Alternatives.



4.2.5 Hardware and Technology Availability

The availability of hardware and tracer gas to detect leaks was the fifth evaluation criterion chosen. A weighting factor of 2.0 was assigned to this criterion. The raw scores assigned to the criterion are below.

Raw Score	Description
5	Proven technology in use at the Hanford Site or other DOE facilities; materials available in the Northwest.
4	Proven technology in use in other similar situations; equipment and materials available in the Northwest.
3	Technology in use in other areas of the United States but for different applications.
2	Prototype technology under development with only a few field-scale applications.
1	Technology is theoretical only and has not progressed beyond bench scale.
0	Unacceptable availability.

The leak detection options have been used in industry for many years. Each of the options are proven technologies; however, only a few have recently been used for radioactive leaks. A higher score was assigned to an alternative that used proven available technology. A reduced score was assigned to an alternative with poor equipment availability.

4.2.5.1 Liquid Dye. The liquid dye test relies on a technology that is more conventionally used for aboveground or underwater piping systems. Although the method is a proven technology, it does not qualify as a directly available alternative. Accordingly, a score of 3.0 was assigned.

4.2.5.2 Camera Study. The camera study is a proven and available technology that is used extensively under similar applications. However, because cameras have a 4-in. pipe diameter limitation, this technique could not be used exclusively for the 200-BP-1 pipelines. Due to these limits, a score of 1.0 was assigned.

4.2.5.3 Nondestructive. As discussed in Section 3.0, nondestructive inspection is a proven, available, and commonly used technology. It is not commonly used for leak detection and a quantitative result is very difficult using this method. A score of 3.0 was assigned to this method.

4.2.5.4 Air Pressure. As is the case with the nondestructive methods, air pressure is a proven, commonly available technology that does not determine leak location. Because of these limitations, a score of 3.0 was assigned.

Table 14 identifies detection methods ranked with the availability criterion.

Table 14. Hardware and Technology Availability - Leak Detection Alternatives.

Alternative	Raw Data	Weight Factor	Weighted Score
Liquid Dye	3.0	2.0	6.0
Camera Study	1.0	2.0	2.0
Nondestructive	3.0	2.0	6.0
Air Pressure	3.0	2.0	6.0
Freon	4.0	2.0	8.0
Halon	4.0	2.0	8.0
Helium	5.0	2.0	10.0

4.2.5.5 Freon Tracer Gas. This alternative uses proven and available tracer gas technology where soil probes installed along a pipeline are used to collect soil gas samples. Soil gas surveys and GC technologies are also common and readily available. Therefore, a score of 4.0 was assigned.

4.2.5.6 Halon Tracer Gas. The technologies needed for the halon tracer gas technique are identical to freon. Currently, a halon leak detection system is installed at Fairchild Air Force Base near Spokane, Washington, to monitor an existing petroleum tank farm. Due to the availability and current use factors, a score of 4.0 was assigned.

4.2.5.7 Helium Tracer Gas. The use of helium and appropriate detection equipment is currently used at the Idaho National Engineering Laboratory. The equipment is readily available in the Northwestern United States. Accordingly, a score of 5.0 was assigned.

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5.0 CONCLUSIONS

5.1 PIPE PENETRATION

The two pipe penetration alternatives evaluated in this engineering study were as follows:

- Standard practice (hand-oriented method)
- Hot tap method of pipe preparation.

Table 15 shows that the hot tap procedure ranked first overall even though it ranged below the standard method in two categories, cost and hardware availability. The hot tap method ranked considerably higher than the standard practice, especially in the environmental and worker safety criteria.

5.2 LEAK DETECTION

Underground piping leak detection alternatives evaluated in Section 4.0 were ranked according to selected criteria. Table 16 provides a summary of the advantages and disadvantages of all leak detection alternatives.

As shown in the summary in Table 17, the preferred leak detection method is helium tracer gas, followed by air pressure methods and halon tracer gas. The helium tracer gas technique will determine pipeline integrity while at the same time determining the location of any leaks using portable, easy-to-use detectors. Once a pipeline is pressurized with helium and a 3-h diffusion time has elapsed, helium detection can proceed, providing timely data concerning leaks and their locations.

One small disadvantage is that this is a relatively new technology in the hazardous waste industry and is not widely known. However, the EPA does recognize the method as being one of the new technologies applicable to tightness testing and leak detection (EPA 1989).

The advantages of using the helium tracer gas method are apparent. First, the only worker exposure to subsurface contamination will be limited to the excavation where access is needed for pipeline isolation (hot tapping) and helium pressurization. All helium detection will occur at ground level. Very little waste will be generated, as only soils from access excavations may need to be handled. From a cost standpoint, the helium tracer gas method is less expensive than the halon tracer gas method since there is no requirement for soil probes or laboratory GC analyses. While air pressurization looks to be a viable alternative, helium offers the distinct advantage of locating leaks within 6 in. The air pressurization method does not locate leaks.

Table 15. Summary of Pipe Penetration Alternative Scores.

Table 15.

Evaluation criteria	Weighting factor	Maximum rating possible	Standard practice method score	Hot tap method score
Environmental Protection	4.0	20.0	8.0	16.0
Worker Safety	4.0	20.0	4.0	16.0
Ease of Use	3.0	15.0	6.0	9.0
Cost	2.5	12.5	5.0	2.5
Hardware Availability	2.0	10.0	10.0	6.0
TOTALS	--	77.5	33.0	49.5

Table 16. Summary of Advantages and Disadvantages for Underground Pipeline Integrity Tests for the 200-BP-1 Operable Unit.

Alternatives	Advantages	Disadvantages
Liquid Dye	Technology widely used for pipelines. Low detection time. Dye is nonhazardous.	Liquid waste is generated. Requires excavation. Worker exposure.
Camera Study	Accepted technology. Non-chemical.	Excavation required. High-level training required. Unable to detect minor flaws. Limited to 4 in. pipe or larger. Not able to check system tightness.
Nondestructive	Inexpensive. No damage to system. Non-chemical survey.	High-level training required. Total excavation. Worker exposure. Unable to detect minor flaws.
Air Pressure	Technology widely used for pipelines. Only partial excavation required. Nonhazardous gas (air) required.	Does not locate leak.
Freon	Known technology. Locates leaks. Minimum excavation required.	Harmful to the environment. Soil probes required. Slow diffusion rate. Relatively expensive.
Halon	Known technology. Locates leaks. Minimum excavation required.	Soil probes required. Slow diffusion rate. Relatively difficult to analyze. Expensive.
Helium	Detection at ground level. Reduced worker exposure level. High diffusion rate. Relatively inexpensive. Rapid results of test.	Relatively new technology.

9 1 1 2 7 5 7 0 2 7 9

Table 17. Summary of Leak Detection Alternative Scores.

Table 17.

Evaluation criterion	Weight factor	Maximum rating possible	Liquid dye score	Camera study score	Non-destructive score	Air pressure score	Freon score	Halon score	Helium score
Environmental Protection	4.0	20.0	4.0	16.0	8.0	16.0	12.0	12.0	16.0
Worker Safety	4.0	20.0	8.0	8.0	0.0	16.0	12.0	12.0	16.0
Hardware Ease of Use	3.0	15.0	12.0	3.0	3.0	6.0	12.0	12.0	12.0
Cost	2.5	12.5	7.3	0.0	5.9	12.5	1.8	1.8	11.8
Hardware Availability	2.0	10.0	6.0	2.0	6.0	6.0	8.0	8.0	10.0
TOTALS	--	77.5	37.5	29.0	22.9	56.5	33.8	45.8	65.8

Therefore, the preferred alternative used for underground pipeline leak detection at the 200-BP-1 Operable Unit is the helium tracer gas method. This method has been chosen as the appropriate method for determining pipeline tightness and locating leaks if they exist in the pipeline network. This method has been selected over the other two highly ranked alternatives because of safety, low environmental impact, low cost, and ease of implementation.

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6.0 RECOMMENDATIONS

This engineering study's objective was to evaluate pipe penetration and leak detection techniques that would be applicable for testing underground waste effluent pipelines in the 200-BP-1 Operable Unit. As discussed in previous sections, it is recommended that the hot tap technique be employed to penetrate the 200-BP-1 Operable Unit pipelines. The recommended placement of valves is shown in Figure 8.

It is also recommended that the helium tracer gas method be used to detect pipeline leaks in the 200-BP-1 Operable Unit. Figure 9 illustrates how the recommended pipe penetration alternately coupled with the recommended leak detection alternative would be applied in the field.

It is further recommended that the following be considered prior to testing.

1. Raw data need to be further analyzed carefully to ascertain the true extent of the underground piping within the 200-BP-1 Operable Unit. This includes the readings from the ground penetrating radar survey to further define exact pipeline locations.

2. Field personnel selected to perform the excavation and pipe penetration should be familiarized with the hot tap procedure in the classroom and/or shop and then trained with hands-on experience in a nonradioactive environment before the actual work. A cold test should be conducted in the field as part of the training initiative.

3. A determination should be made as to who will implement the test, onsite personnel or outside contractors. Considerations should include cost, schedule, and training, at a minimum.

4. Vendors should be contacted and interviewed to determine their ability to furnish hardware (valves, saddles, boring tools) and technical expertise to assist in training. This ability must be a prerequisite and part of the bidding process.

5. Original valves and plugs, as well as additional valves, plugs, and taps, should be marked at ground level for future identification.

Figure 8. Recommended Placement of Valves for Isolating Lines in the 200-BP-1 Operable Unit.

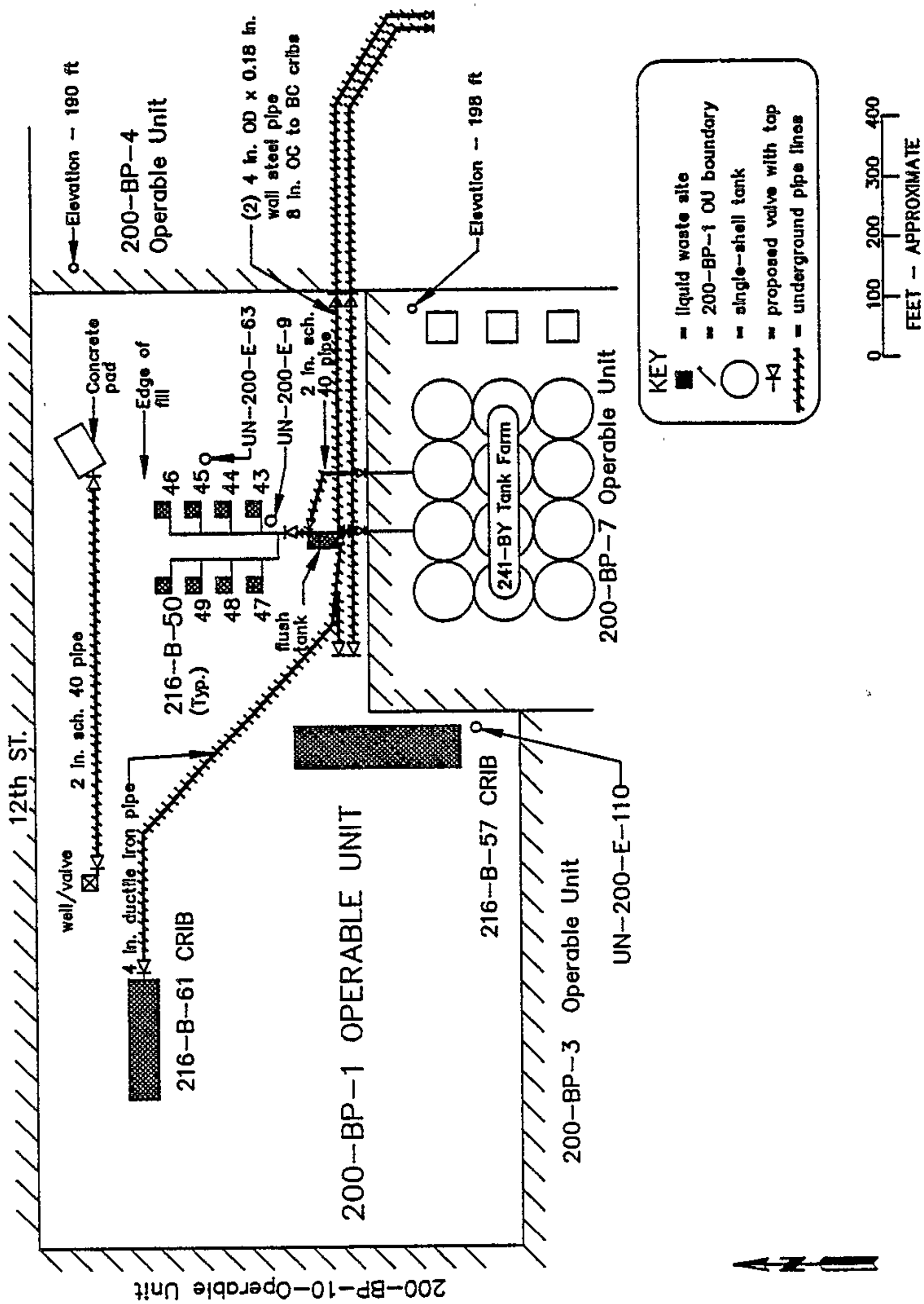

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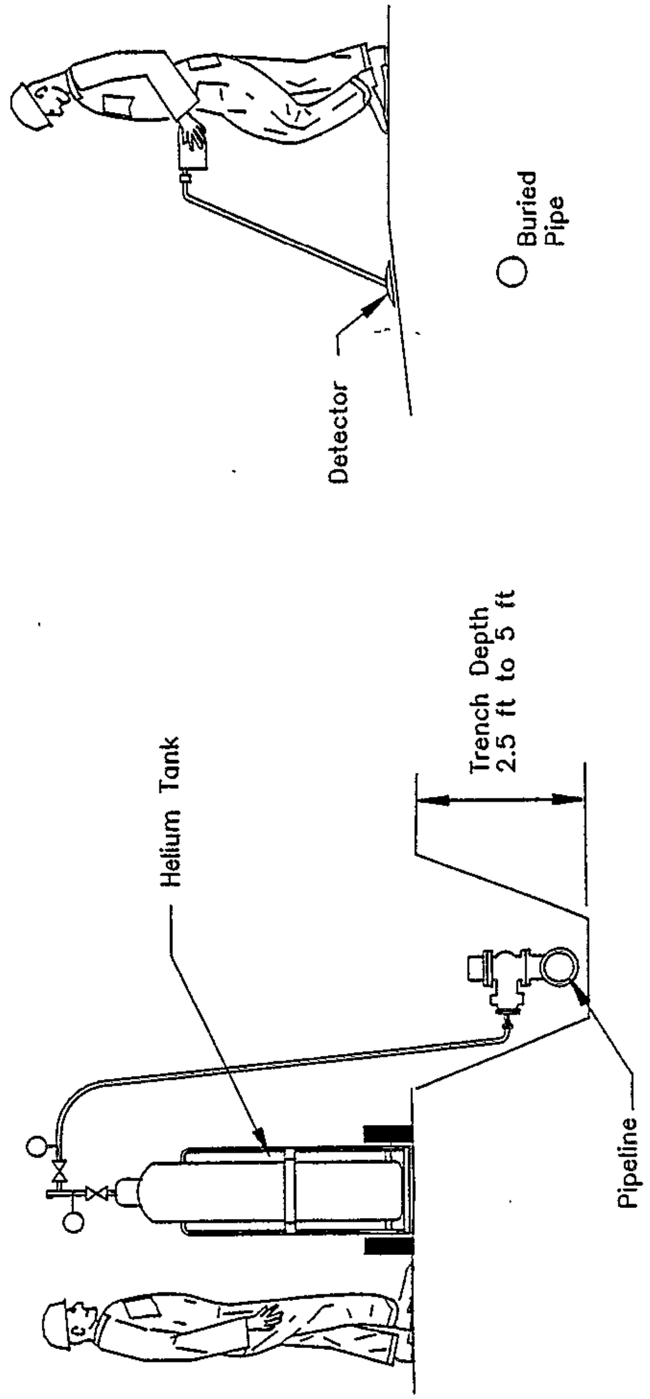
Figure 9. Schematic of Hot Tap Valve and Helium Tracer Gas Leak Detection Techniques.



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Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, Washington State Department of Ecology, U.S. Environmental Protection Agency, U.S. Department of Energy, Olympia, Washington.

RESOURCES

International Piping Services Co., 2900 S. 21st Avenue, Broadview, Illinois.

Mark Products Inc., 575 N. Pastoria Ave., Sunnyvale, California.

Price Brothers, Pressure Pipe Division, 367 West Second Street, Dayton, Ohio.

Reef, John S., *"Hot" Tapping and Plugging of Pressurized Lines, Plugging of Pressurized Lines*, Plant Engineering, April 18, 1974.

Tracer Research Corporation, 3855 North Business Center Drive, Tucson, Arizona.

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APPENDIX A

PIPE PENETRATION COSTS

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APPENDIX A

PIPE PENETRATION COSTS

Labor and material to penetrate underground pipe (after excavation), place devices, and install fittings for the standard practice (hand-oriented) method.

Labor @ $45/h - 30 d, 2 people		$21,600
Miscellaneous tools		1,000
Flanged completion fittings	12 @ $100	1,200
Pipe plugs	12 @ $ 25	300
Valves	2 @ $125	250
Miscellaneous fittings, lubricant, sealants		250
		$24,600

Hot Tap - Pipe Penetration Cost

Labor and material to penetrate underground pipe, place devices, and install fittings for the recommended alternative:

Labor at $45/h 20 d - 4 people	$28,800
Boring machine (2)	1,900
Plug flanges (12)	2,640
Tap flanges (12)	2,640
Insert valves (2)	900
Miscellaneous fittings, lube, etc.	1,920
	$38,800

APPENDIX B

LEAK DETECTION COSTS

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APPENDIX B

LEAK DETECTION COSTS

General	
Labor	$ 45/h
Soil probes	
4 in. 304 SS (2.5 ft)	$420/ea
4 in. 304 SS (5.0 ft)	$535/ea
Inspector labor	$125/h
Liquid Dye	
Labor - 8 d - 2 people	$ 5,760
Dye	50
Excavation	40,000
Pipe penetration - hot tap	38,800
Waste disposal	+
	$85,735+
Camera Study	
Inspector labor, 4 d - 2 people	$ 8,000
Excavation and bracing	80,000
Cameras ($1,640 each)	8,200
Mounting and cable system	10,000
Pipe penetration - hot tap	38,000
	$144,200
Nondestructive	
Inspector labor, 8 d - 2 people	$ 16,000
Excavation and bracing	80,000
	$ 96,000
Air Pressure	
Labor, 4 d - 2 people	$ 2,880
Compressor fuel	40
Pressure gauge (2)	40
Regulator	171
Pipe penetration	38,800
	$ 41,931

Tracer gas - freon/halon	
Soil probes	
4 in. 2.5 ft x 75 probes	$ 31,500
4 in. 5.0 ft x 75 probes	40,125
Installation labor, (15 d - 2 people)	10,800
Gas	80
Labor to set up and draw samples (6 d - 2 people)	4,320
Regulator	
Pressure gauge (2)	40
Pipe penetration - hot tap	38,800
Sample analysis $30/sample- 150 samples	4,500
	$130,165

Tracer gas-helium	
Mark IV 9820 Detector	$ 5,500
Pipe penetration - hot tap	38,800
Labor, 4 d - 2 people	2,880
Helium gas	40
Regulator	171
Pressure gauge (1)	20
	$ 47,411

6

200-BP-1 GROUNDWATER WELL

INSTALLATION, TASK 6

STATUS, DECEMBER 17, 1990

Well	Status
699-48-50 699-49-57(B) 699-50-53(B)	Well construction activities are complete. Development activities will be completed by December 27.
699-52-54 699-52-57	Drilling activities are complete. Temporary screens have been installed for aquifer testing.
699-55-55	Drilling depth - 289 ft. Drilling has been delayed due to a bent casing.
299-E33-38	Drilling depth - 213 ft. Contamination found at 197 ft.
299-E33-39	Drilling depth - 66 ft. No contamination found to date.
299-E33-40	Drilling depth - 204 ft. Contamination found at 197 ft.

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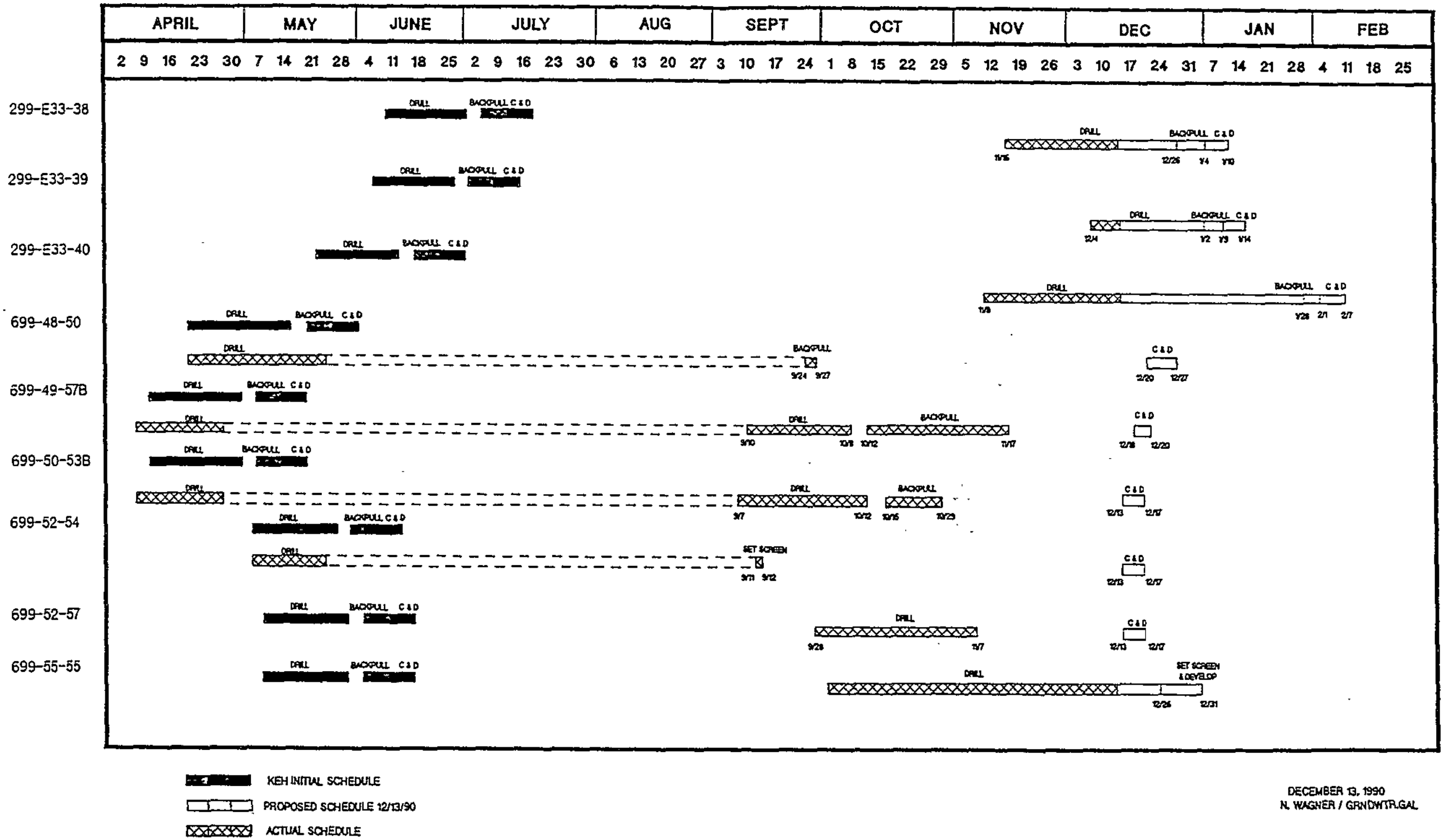
PROPOSED SCHEDULE FOR 200-BP-1 GROUNDWATER MONITORING WELLS PROJECT 90E-GFW-121



DECEMBER 13, 1990
N. WAGNER / GRNDWTR.GAL

Attachment 6

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Attachment 7

GROUNDWATER WELL REMEDIATION

1. Screen intervals have been modified.
2. Turbity measurements will be completed this week to determine if further well development will be required.
3. Begin annular seal installation in January.

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GROUNDWATER SAMPLING

1. Off site laboratory has been identified.
2. Sampling is scheduled to begin January 7, 1991.

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Attachment 9

SOURCE AND VADOSE SAMPLING

1. Draft HWOP from KEH is scheduled to be submitted January 4, 1990.

2. Dry run for sample collection will be conducted during the first part of January.

3. Vadose boreholes locations have been surveyed.

4. OSM has submitted a schedule identifying laboratory support source and vadose needs. The PNL 325 Laboratory is scheduled to be the primary lab with the WHC 222-S Laboratory being used as a split lab.

5. Physical Sampling:

   - Whole body - 25-35 mrem/Hr per sample

   - Dose limits - 300 mrem/Hr per week

   - Work Plan:

     First borehole - split tube sample every 2 ft.

     Remaining boreholes - split tube sample every 2.5 ft.

   - Purposed Sampling Frequency:

     All boreholes - split tube every 5 ft. or change of lithology

200-BP-1 Operable Unit Managers Meeting
December 18, 1990

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